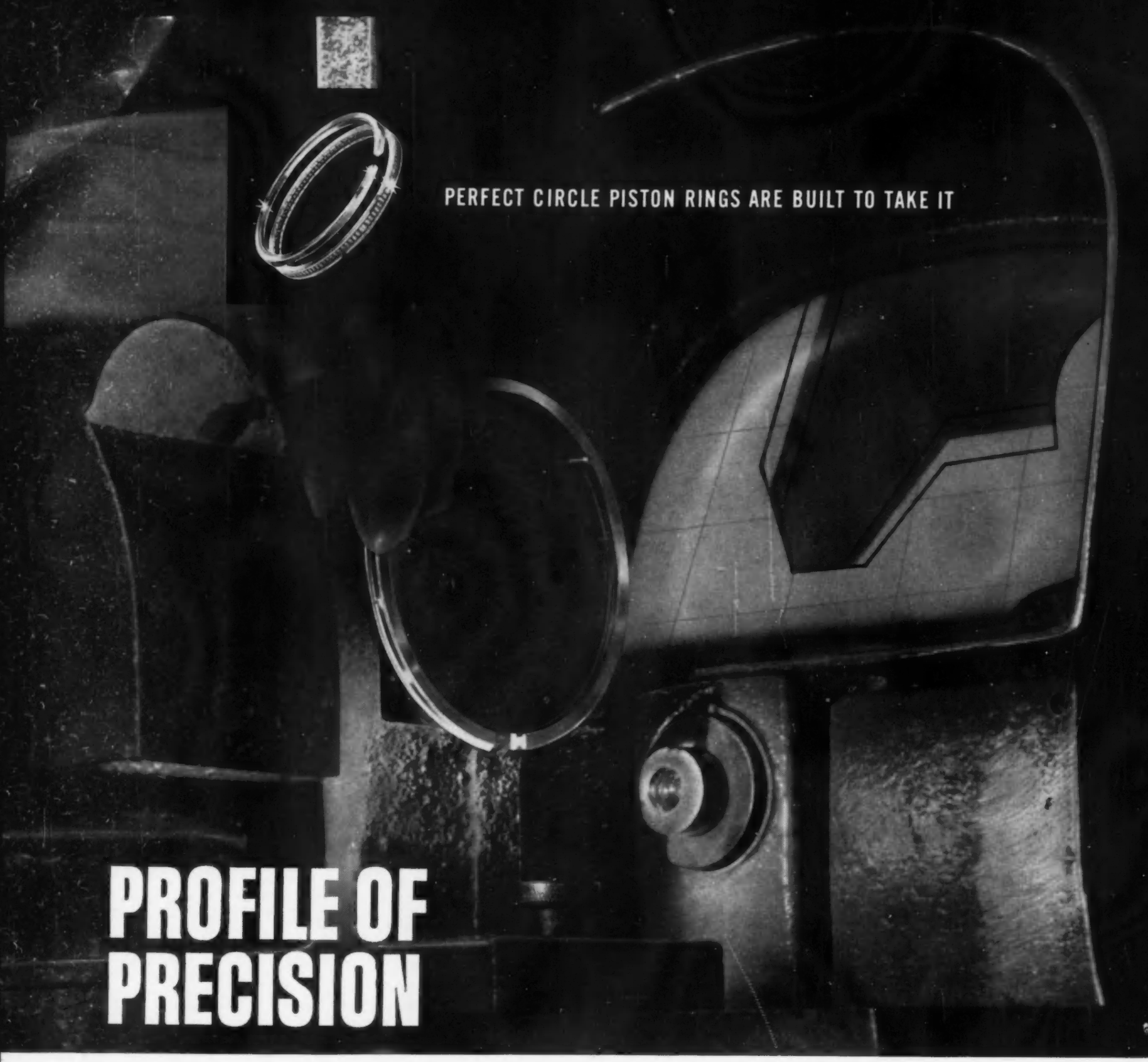
SEPTEMBER 1960

SAE

PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

JOURNAL

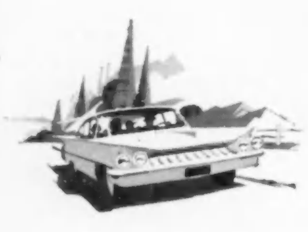


PROFILE OF PRECISION

You are looking at the profile of a piston ring magnified many times on a powerful comparator. These highly-accurate optical devices are used in the factory to compare finished rings with standard dimensional specifications.

The comparator is but one of the many sensitive instruments employed by Perfect Circle to maintain uniform high quality in all production rings. Such precise control of machine operations assures you of better ring performance.

Whatever the need, Perfect Circles are built to take it. Put your trust in the ring preferred by more engine makers and mechanics than any other—Perfect Circle.



PERFECT CIRCLE

PISTON RINGS · PRECISION CASTINGS · POWER SERVICE PRODUCTS · SPEEDOSTAT

HAGERSTOWN, INDIANA · DON MILLS, ONTARIO, CANADA

Contents • September 1960

INDEX of 1960 SAE Journal technical articles will appear in the December 1960 issue

To order papers on which articles are based, see p. 6.

Continued on page 2

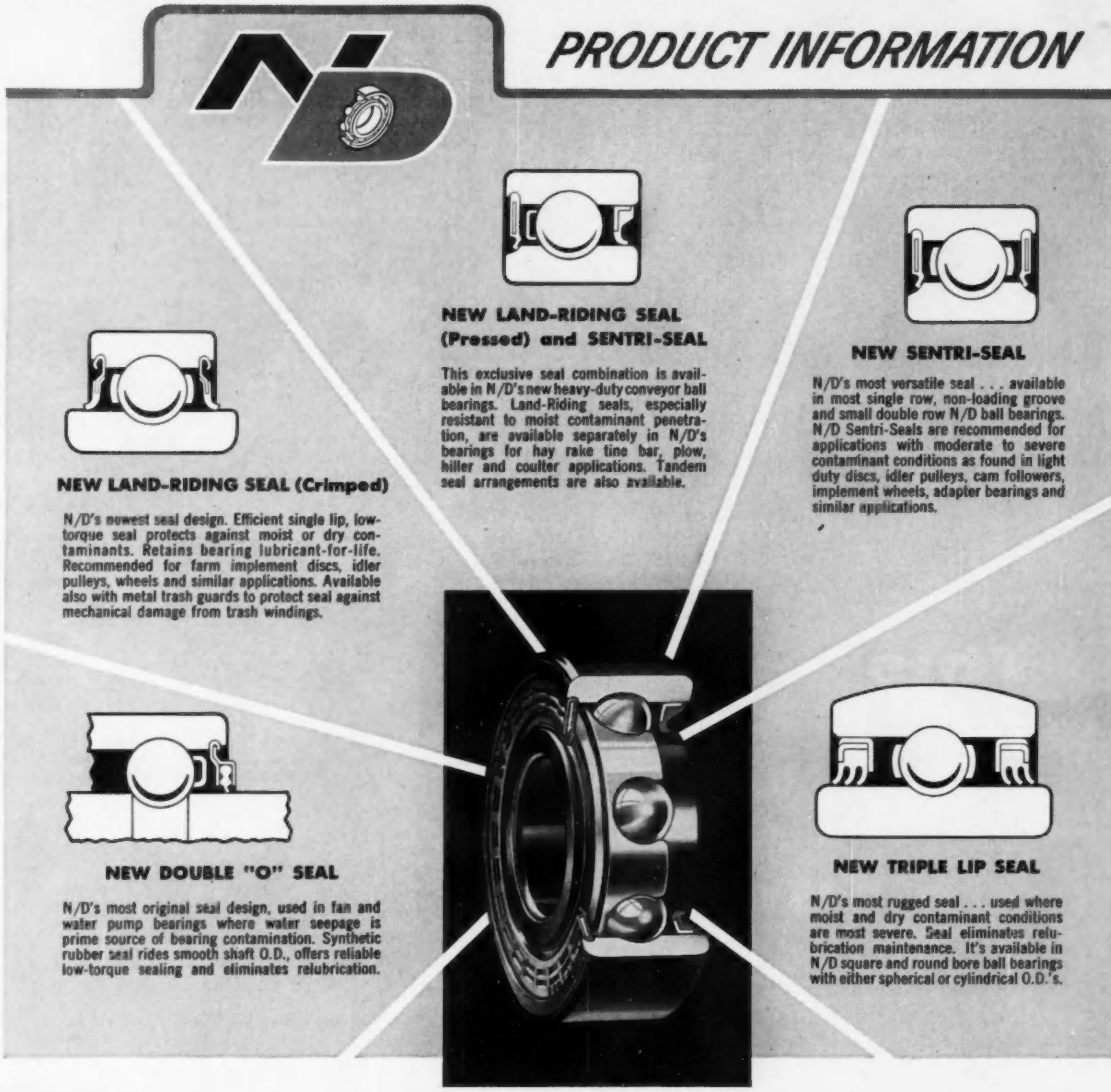
Contents • September 1960 • Continued

More on page 1

To order papers on which articles are based, see p. 6.

A complete index of all Journal technical articles, from January through December, will appear in the December issue. All Journal technical articles are indexed by Engineering Index, Inc. SAE Journal is available on microfilm from University Microfilms, Ann Arbor, Mich.

SAE JOURNAL, September, 1960, Vol. 68, No. 9. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 485 Lexington Ave., New York 17, N. Y. $1 per number; $12 per year; foreign $14 per year; to members 50¢ per number, $5 per year. Entered as second class matter, Sept. 15, 1948, at the Post Office at Lancaster, Pa., under the Act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of Feb. 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1918. Additional entry at New York, N. Y. Second class postage paid at Lancaster, Pa. and additional office N. Y. C.


PRODUCT INFORMATION
NEW LAND-RIDING SEAL (Crimped)
N/D's newest seal design. Efficient single lip, low-torque seal protects against moist or dry contaminants. Retains bearing lubricant-for-life. Recommended for farm implement discs, idler pulleys, wheels and similar applications. Available also with metal trash guards to protect seal against mechanical damage from trash windings.
NEW LAND-RIDING SEAL (Pressed) and SENTRI-SEAL
This exclusive seal combination is available in N/D's new heavy-duty conveyor ball bearings. Land-Riding seals, especially resistant to moist contaminant penetration, are available separately in N/D's bearings for hay rake tine bar, plow, hiller and coulter applications. Tandem seal arrangements are also available.
NEW SENTRI-SEAL
N/D's most versatile seal . . . available in most single row, non-loading groove and small double row N/D ball bearings. N/D Sentri-Seals are recommended for applications with moderate to severe contaminant conditions as found in light duty discs, idler pulleys, cam followers, implement wheels, adapter bearings and similar applications.
NEW DOUBLE "O" SEAL
N/D's most original seal design, used in fan and water pump bearings where water seepage is prime source of bearing contamination. Synthetic rubber seal rides smooth shaft O.D., offers reliable low-torque sealing and eliminates relubrication.
NEW TRIPLE LIP SEAL
N/D's most rugged seal . . . used where moist and dry contaminant conditions are most severe. Seal eliminates relubrication maintenance. It's available in N/D square and round bore ball bearings with either spherical or cylindrical O.D.'s.

This is the birth of a Burton coil spring

Here is the exact moment when a rod of steel becomes a Burton Coil Spring. This is the moment when the sum total of years of experience, engineering know-how, quality control and scientific operation of the latest and most modern manufacturing equipment all combine to produce quality.

Rugged, tough, most years of service . . . that's a Burton Coil Spring or a Burton Leaf Spring. Millions in use on every type of moving vehicle. Dependable performance results from exacting specifications and proper controls we maintain throughout the manufacturing processes.

The engineering ideas are born here

On the drawing board . . . out in the shop . . . experienced minds at Burton are concentrating on the problems of automobile and truck springs. We can help you solve your problem of more payload and less weight. Call on us. 37 years of knowing-how.

BURTON Auto Spring Corporation

WESTERN AVENUE AT 48TH STREET • CHICAGO 32, ILLINOIS

Since 1923 we have manufactured automotive springs exclusively

Briefs of SAE PAPERS

These digests are provided by ENGINEERING INDEX, which each year abstracts 30,000 engineering articles from 1500 different publications and classifies them into 249 "fields of engineering interests."

To order the SAE papers digested here, circle the numbers in the "Readers Information Service" blank on p. 6 corresponding to the numbers appearing after the titles of the digests of the papers you want.

AEROSPACECRAFT

Nitrosyl Chloride Solar Regenerative Fuel Cell System, W. E. McKEE, J. D. MARGERUM, E. FINDL, W. B. LEE. Paper No. 179C. Problems and theoretical aspects of photochemical type of solar regenerative system; status report on regenerative nitrosyl chloride fuel cell system, developed by Sundstrand Corp.; in this system, Cl_2 and NO are combined in fuel cell to produce electricity, nitrosyl chloride (NOCl) formed in process is subsequently photo-dissociated into chlorine and nitric oxide; fuels can be stored for future use or fed back into fuel cell; experimental results.

GROUND VEHICLES

U. S. Army Research and Development Program on Fuel Cells, **S. J. MAGRAM, B. R. STEIN.** Paper No. 179B. Summary of Army fuel cell program which includes investigations of hydrogen oxygen, molten salt, consumable electrode, regenerative, redox, and ion-exchange membrane systems; Signal Corps activity, various groups involved and report status of each project given; Ordnance Corps fuel cell program, carried out by Diamond Ordnance Fuze Laboratories and directed exclusively to problem of providing power plant for vehicular propulsion.

Noise Quieting Principles for Rotary Type Power Lawn Mowers, W. C. SPERRY. Paper No. 183A. Results of 200 tests made to determine acoustic principles that must be considered; noise characteristics of mowers and their components were determined with aid of Armour Research Foundation reverberation chamber; engine, blade, deck, and muffler were studied and six major noise components established; two components of engine noise can be reduced by using cover for exposed engine above deck; noise control abilities defined as cover and deck factors.

Vibration and Noise Control of Outboard Motors and Other Products, J. W. MOHR. Paper No. 183B. Approach taken by Outboard Marine Corp., Milwaukee, Wis., to solve problem of noise and vibration control of outboard motors, rotary lawn mowers, etc.; design of resilient mounting system, supplying combustion air to enclosure, engine exhaust noise treatment, and sealing of enclosure; rotary lawn mower vibration and noise treatment, and vibration control of 3-wheeled vehicle described.

Technological Advances in Hydraulic Brakes for Motor Trucks, J. THOMAS. Paper No. 184A. Summary of improvements made which include development of higher fluid boiling points with greater stability, better rubber parts, improved design, anti-fade lining, retarders, liquid brakes, and split brake systems; three split systems under development; airboosted hydraulic, vacuum boosted hydraulic, and multiple master cylinder.

Air Brakes — Yesterday-Today and Tomorrow, R. B. PALMER. Paper No. 184B. Examination of various air brake systems; reference made to "Tractor Trailer Protection" system, developed by AMA-TTMA committee and their consultants; attempt is made to describe expected brake improvements, both in foundation brake and in air supply; wedge-operated brake, where shoes are actuated by wedge at right angles to shoe centerline such as British, or Fawick-Girling design; foundation brake which doubles as retarder, under development by Wagner Electric Corp.

PRODUCTION

Polyvinyl Alcohol Solution as Quenchant for Hardening of Steel, P. E. CARY, E. O. MAGNUS, A. S. JAMESON. Paper No. 178A. Aqueous solutions of polyvinyl alcohol were studied and compared with water and oil as quenchants; four degrees of quenchant

continued on p. 6

Readers' Information Service

Advertising Information Available

- If you would like further engineering information on any of the products ADVERTISED in this September 1960 issue, CIRCLE THE APPROPRIATE PAGE NUMBERS in the list BELOW. Requests will be forwarded to the advertisers.
- Please fill in your NAME, COMPANY, AND ADDRESS on the BACK of this form.

3	114	137	159	181 top left
4	115	138	160	181 bottom left
7	116	139	161	181 right
8	117	140	162	182 top left
9	118	141	163	182 bottom right
11	119	142	164	182 right
12	120	143	165	183
13	121	144	166	184
14	122	145	167	185
15	123	146	168	186
16	124	147	169	187
17	125	148	170	188
18	128	149	171	189
19	129	150	172	190
20	130	151	173	191
21	131	152	174	193
22	132	154	175	194
24	133	155	176	Inside front cover
111	134	156	177	Inside back cover
112	135	157	178	Outside back cover
113	136	158	180	

- COMPLETE PAPERS on which September, 1960 SAE Journal articles are based are available in multilith form. Circle PAPER NUMBERS ON THE BACK OF THIS FORM of any papers you wish to buy.

Briefs of SAE PAPERS

continued from p. 5

agitation were produced by use of different quenching fixtures; it is shown that solution in concentration by weight of 0.15% has cooling ability between that of water and oil; it was found that polyvinyl alcohol solutions are more sensitive to change in quenchant agitation than water.

New Nitriding Process for Increased Wear and Fatigue Resistance, J. H. SHOEMAKER, G. BIDIGARE. Paper No. 178B. Tufftride process is carried out in low carbon or mild steel containers in externally heated gas or electrically fired furnaces, capable of operating temperatures within range of 1000–1050 F; results of tests made on Faville-LeVally Falex Lubricant Testing Machine to demonstrate anti-seizure and anti-galling properties of Tufftrided surfaces; hardness and depths and fatigue life; examples of various automotive applications.

Engineering Convection in Heat Treat Furnaces, J. HUEBLER. Paper No. 178C. Problems in design of convection systems such as fan design of axial or radial flow; selection of type, size and speed depends upon available materials, and horsepower required, as dictated by process requirements; various fan and circulation arrangements; characteristics of work of importance: size, shape, and distribution of pieces; thermal conductivity and specific heat; rate at which carbon can be absorbed in case of carburizing; resistance of work load to passage of wind; other considerations.

Radioisotopes Broaden Approach to Machining Studies, M. PALIOBAGIS; E. J. KRABACHER. Paper No. 181A. Three conventional methods available for measuring tool wear; radioactive tool wear procedures; choice of radioisotope depends on chemical composition of tool material, half-life of available isotopes, and method to be used to detect activity and specific activity of tool; tabulation of physical characteristics of effective radioisotopes; comparison of radioactive and conventional tool wear methods; special studies with radioactive tools and results obtained.

Applications of Radioisotopes in Machining Operations, J. H. TOLAN. Paper No. 181C. Process of Compton interaction between single photon and orbital electron is explained; adaptation of backscatter technique explored by Lockheed Nuclear Products may provide control for various machining operations; use of radioisotopes for monitoring cutting tools; possible applications include control of contour of screw threads during grinding; measure of dimensions and location of internal cuts, and measure of wall thickness of bored openings in castings; geometry employed by source-collimator detector.

Value Engineering — Key to Productivity and Profitability, J. F. PRENDERGAST. Paper No. 182A. Approach taken to value analysis, developed in 1947 at General Electric Co., Schenectady, N. Y.; role of value engineering and results obtained.

MATERIALS

Marylbond Process — Seven Years' Experience, P. E. ROGGI, C. E. KIERNAN. Paper No. 180A. Process for making laminate on continuous basis developed by U. S. Rubber Co.; steps in treatment for ferrous metals, principally cold rolled steel; in case of aluminum, alkaline cleaner strong enough to give slight etch followed by phosphoric chromic treatment is satisfactory; adhesives used; preparation of vinyl sheeting; forming operations successfully performed include shearing, crimping, punching, drilling, brake-press bending, stamping, roll forming, and cold drawing; emboss welding method.

Production and Application of Vinyl-Coated Steel, G. H. RENDEL. Paper No. 180B. Vinyl-coated steel is usually made by either laminating process or plastisol process which both result in products with same characteristics; U. S. Steel vinyl-coating line is designed to process coils weighing up to 10,000 lb with widths up to 52 in. and thicknesses from 16 to 32 gage; flow diagram of steps used; applications in appliance field and automotive industry; properties of vinyl-coated steel which may be processed, formed and fabri-

continued on p. 113

Readers' Information Service

SAE Papers Available — September 1960 issue

- If you would like complete copies (in multilith form) of papers on which September SAE Journal articles are based, CIRCLE THE APPROPRIATE PAPER NUMBERS in the list below. PAPER NUMBERS are indicated at the END of each article. PRICES are listed below.

S245	178C	180D	184A	195D	211D	SP-175
T44	179A	181A	184B	196A	216B	SP-184
154C	179B	181B	184C	198A	CRC 342	SP-330
171B	179C	181C	185A	199A	CRC 343	
177B	180A	182A	186A	203A	CRC 344	
178A	180B	183A	187A	208B	CRC 345	
178B	180C	183B	189A	210A	CRC 348	

Prices:
Papers: 50¢ each to mbrs.; 75¢ to nonmbrs.
SP-175: $1 each to mbrs.; $2 to nonmbrs.
SP-184: $1.50 each to mbrs.; $3 to nonmbrs.
SP-330: $2 each to mbrs.; $4 to nonmbrs.
CRC 342, 344, and 345; $1 each to mbrs.; $2 to nonmbrs.
CRC 343: $2 each to mbrs.; $4 to nonmbrs.
CRC 348: $3 each to mbrs.; $6 to nonmbrs.

ORDER BLANK

TO: Society of Automotive Engineers, 485 Lexington Ave., New York 17, N.Y.

PLEASE SEND ME:

... The SAE Papers and Special Publications whose numbers I have circled above.

.... Check or coupons enclosed

.... Bill Company .... Bill me

PLEASE SEND ME:

... Information about the advertisers' products and services circled on the back of this form.

NAME ....

COMPANY ....

COMPANY ADDRESS ....

INDUSTRIAL PLASTERS FOR THE TOOLING INDUSTRY

Material	Principal Use	Description
	LOW EXPANSION DENSITES	
Densite K-12	Duplicator Models	Lowest expansion provides great accuracy, high strength and hardness
Tooling Densite	Duplicator Models, Splash Castings, Screeding, Rodding, Loft Template Work	Low expansion; special ingredients insure longest working time of any tooling plaster of comparable set
Densite K-17	Pattern & Model Making	A low expansion, high strength plaster used extensively for Keller patterns
Densite K-25	Pattern & Model Making	Same general characteristics as K-17 but is more plastic and builds up better on splash castings than any other high strength plaster
	HIGH EXPANSION DENSITE	
Densite K-20	Pattern Making	Gives necessary high expansion to patterns when necessary to compensate for shrinkage of aluminum or zinc alloy metals as Kirksite, etc.
	REGULAR MOLDING PLASTER	
Sunflower Molding L.E.	Temporary Patterns Waste Molds	A general purpose tooling plaster. Has lowest expansion of all molding plasters on market. Lower cost than Densites.
	SPECIALTY	
Breakaway	Expendable Mandrels For Forming Plastic Casts	A premium product for formation of irregular ducts and tubes. Immersion in hot water softens the plaster core and permits easy removal. Colored buff for easy identification.

PHYSICAL PROPERTIES	Pouring Consistency (PC)	Setting Time Gillmore Needle Initial	Setting Time Gillmore Needle Final	Setting Expansion % Percent	Setting Expansion Inch Per Inch	Compressive Strength 1 Hour After Set P.S.I.	Compressive Strength Dry P.S.I.
Sunflower	68-70	38-50 min.	50-65 min.	.17 to .19	.0017 - .0019	1000-1100	2100-2400
Sunflower L.E.	68-70	38-50 min.	50-65 min.	.09 to .11	.0009 - .0011	1000-1100	2100-2400
Densite K-12	36-37	25-35 min.	35-45 min.	.035 to .045	.00035 - .00045	2500-3000	5600-6300
Densite K-17	43-45	20-30 min.	30-40 min.	.06 to .07	.0006 - .0007	2000-2500	5000-6000
Densite K-20	41-43	30-40 min.	40-50 min.	1.0 to 1.2	.01 - .012	900-1200	2200-2700
Densite K-25	44-46	30-40 min.	40-50 min.	.04 to .05	.0004 - .0005	1900-2400	4800-5800
Tooling Densite	38-40	25-35 min.	35-45 min.	.045 to .060	.00045 - .0006	2500-3000	5600-6300
Breakaway	110-120	40-50 min.	50-60 min.	.09 to .11	.0009 - .0011	60-80	250-350

YOUR BEST BUY IS INDUSTRIAL GYPSUM BESTWALL BUILDING PRODUCTS

BESTWALL GYPSUM COMPANY
Ardmore, Pennsylvania
Plants and offices throughout the United States

Rim

Only Goodyear Rims have *Bond-A-Coat Finish,* for lasting protection against rust and corrosion

conditions. And you get the positive air seal provided by Goodyear's famous Tru-Seal.

Goodyear makes rims in widths up to 37″ and in diameters up to 49″. To prevent premature tire and rim failure, it pays to buy and specify rims job-fitted by Goodyear. See your local rim distributor, or write: Goodyear, Metal Products Division, Akron 16, Ohio.

Send for Free Goodyear Rim Catalog
—84 pages of facts and pictures on Goodyear's complete line of rims for every type of vehicle.

YEAR

More tons are carried on Goodyear Rims than on any other kind

Tru-Seal—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

EATON 2-SPEED TANDEMS

give you all the advantages of BOTH

EATON 2-SPEED AXLES and EATON TANDEM DRIVES

★ *Double* the conventional number of available gear ratios

★ Power when you need it; speed when you want it

★ Engine operation within the most efficient, economical speed range

★ Low stress and wear on axle, clutch, transmission, and drive line

★ Simple, low-cost maintenance

★ Long truck life; thousands of extra low-cost miles

★ Short over-all length; maximum strength with minimum weight

★ Simplified design; few parts; easy, low-cost maintenance

★ Most parts interchangeable with standard Eaton 2-Speed Axles

★ No need to match tires; Eaton's inter-axle differential eliminates wheel-fight

★ Power equally transmitted to both axles

★ Driver-controlled inter-axle differential lock-out for extra traction when needed

Wide range of capacities. Eaton Tandems are also available in Single and Double Reduction types.

For hauling operations which require a combination of speed and power together with the load-carrying ability of tandem equipment, Eaton 2-Speed Tandems make big savings in hauling costs. Tell your truck customers about the many exclusive profit-building features they can get only in Eaton 2-Speed Tandems.

EATON

EATON

AXLE DIVISION

MANUFACTURING COMPANY

CLEVELAND 10, OHIO

DOW

Proving ground for

AUTOMOTIVE CHEMICALS

At Dow, where the test tube often serves as test track for automotive fluids, there is a dedicated group of men who are exceedingly car conscious. These men of Dow's Automotive Chemicals Laboratories—car buffs in their own right—work together enthusiastically with automotive engineers on a wide range of developmental applications, both current and future. The results of this natural cooperation may take the form of a better brake fluid, a safer metal cleaner, or a synthetic lubricant . . . one with properties for "years ahead" applications such as the new polyphenyl ethers . . .

NEW LUBRICANTS SHRUG OFF OXIDATION, RADIATION AT HIGH TEMPERATURES

Polyphenyl ethers exhibit marked improvements in lubricating properties and the ability to "take it" under adverse conditions. They're the result of a long range research program on synthetic lubricants at Dow . . . one of primary interest to forward-thinking automotive engineers.

Synthetic lubricants pass lubricity exam for power steering pumps.

Continuous research on synthetic lubricants in Dow's Automotive Chemicals Laboratories has spotlighted the polyphenyl ethers. These chemical materials have exceptional lubricating properties and excellent stability in the presence of oxidation, radiation and high heat.

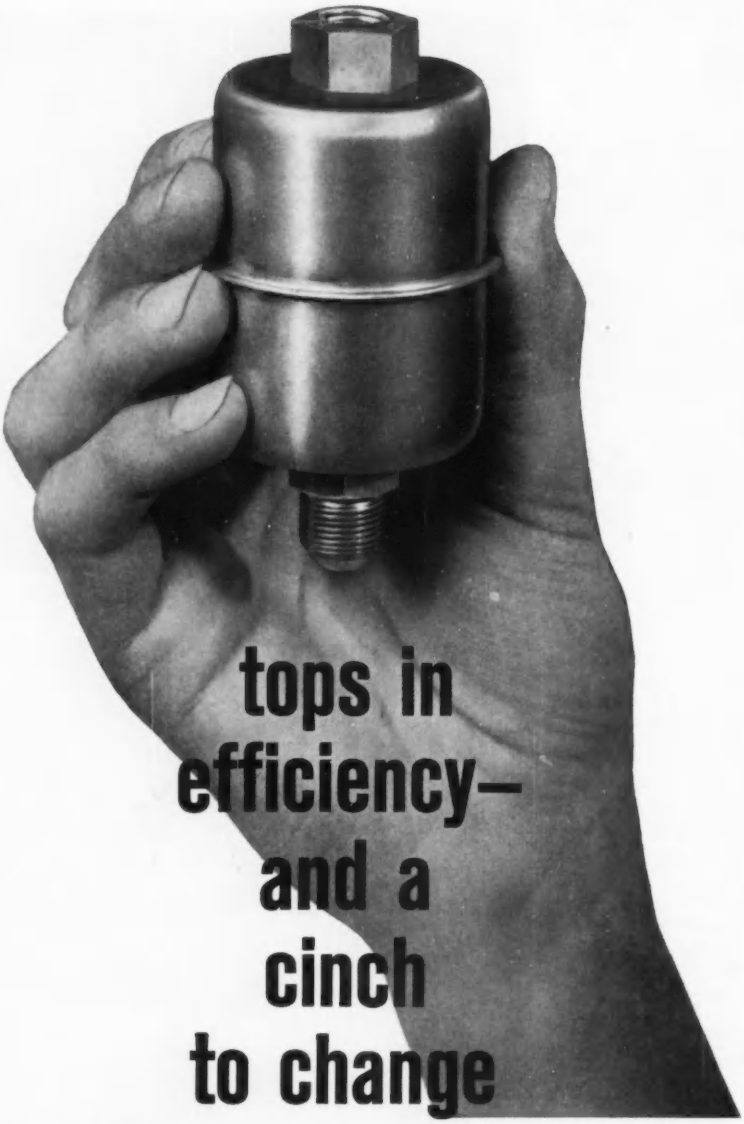
Their lubricity is comparable to the diester lubricants; in the Shell 4-Ball Wear Test, for example, the scar diameter is 0.9 mm. when operating at 600 rpm and 400°F for one hour at a loading of 50 kg. Polyphenyl ethers are resistant to radiation—changes in viscosity are minor after absorption of 1×10^{11} ergs per gram. In a non-oxidizing atmosphere, some polyphenyl ethers withstand 800°F for about 100 hours. In an oxidizing environment polyphenyl ethers can be used for long periods of time at temperatures up to 600°F. Low temperature use is currently limited to 30°F.

Dow is currently working with industry to perfect practical applications. The high resistance to radiation of polyphenyl ethers suggests their use in nuclear-powered aircraft and surface vehicles.

This research and developmental work is part of an over-all program on synthetic lubricants of all types, including the large and versatile polyglycol family. The polyglycols are characterized by many desirable lubricating properties. They have a high natural viscosity index, are non-carbonizing, and display improved oxidation and shear stability, sludge and varnish resistance. Polyglycol lubricants are used today in such diverse applications as crankcases, gas turbine engines, and hydraulic fluids.

V. I. improver research shifts into high

Although viscosity index improvers are young as additives go, they're doing a man-sized job in many lubricating oils. Continuous research on them



HERE'S ALL YOU DO! Unscrew the two fittings that join the Purolator GF-11 Filter to the fuel line. Throw away the dirty filter. Fasten in the replacement. Now you're ready for 5,000 miles of efficient, trouble-free fuel filtration. Total time involved? *Less than 5 minutes.*

MOTORS RUN SMOOTHER . . . Because this Micronic® filter removes dirt, metal, rust, scale and gum . . . even microscopic particles down to 5 microns.

ADAPTABLE TO ALL GASOLINE ENGINES. Purolator fuel filters like the GF-11 shown above, are standard equipment on most 1960 cars. However, it can be incorporated into the fuel system of almost *any* gasoline engine — automotive, portable or marine.

MORE ADVANTAGES. Easy installation and replacement is a big reason for the popularity of the Purolator GF-11 Fuel Filter. But here are more:

°PEAK EFFICIENCY. Because Purolator replacement filters are inexpensive, and easily installed, chances are they'll be replaced at proper intervals — *and always work at peak efficiency.*

°LONGER SERVICE LIFE. Because of the special pleated construction of the filtering unit, the GF-11 has fully *70 square inches* of filtering surface. It operates longer at peak efficiency.

°COMPACTNESS. The GF-11 measures about 3" by 1⅞". It can be installed either horizontally or vertically.

°VERSATILITY. The GF-11 Filter can be installed as an O. E. M. item on practically any gasoline-engine — from sport cars and garden tractors to power mowers and midget racers.

For complete information on the GF-11 and other Purolator filters, write to Purolator Products, Inc., Department 3849, Rahway, New Jersey.

Filtration for Every Known Fluid

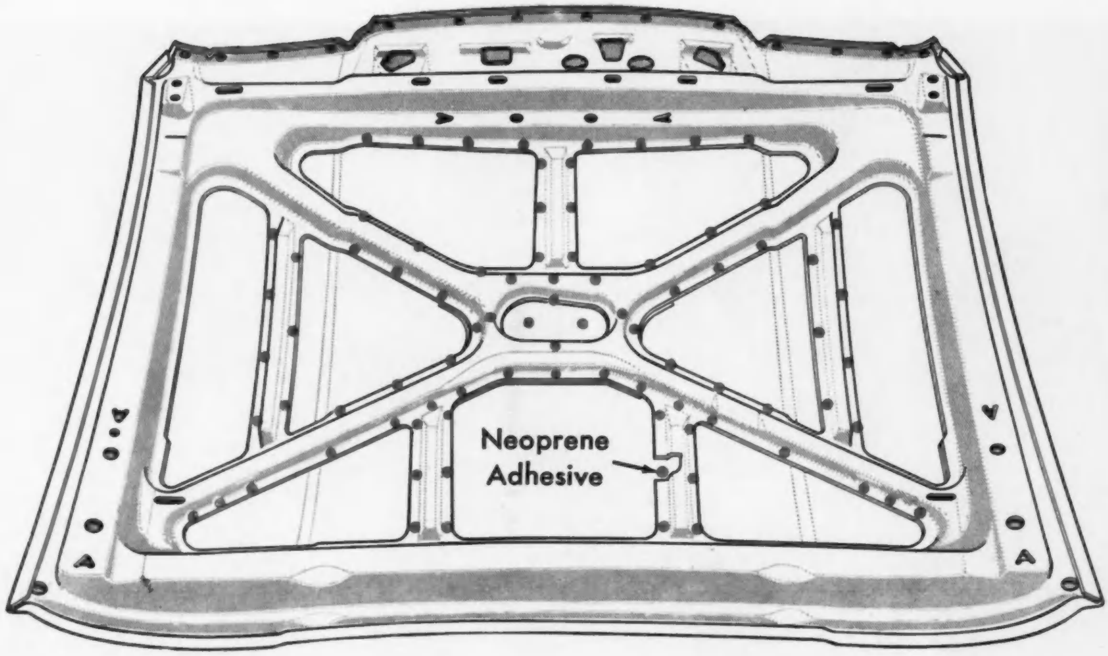
PUROLATOR PRODUCTS, INC.

Rahway, New Jersey, and Toronto, Ontario, Canada

Stainless steel

lifts things above the ordinary! Stainless steel reflects gleaming beauty—*solid* beauty! It won't peel . . . and it resists heat, dents, scratches and corrosion. In fact, no other commercially available metal endures like stainless. No wonder designers and consumers all like it! And remember: The *best* stainless steels are made with Vancoram Ferroalloys! Vanadium Corporation of America, 420 Lexington Avenue, New York 17, N. Y. • Chicago • Cleveland • Detroit • Pittsburgh

VANADIUM
CORPORATION OF AMERICA
Producers of alloys, metals and chemicals



90 NEOPRENE "SPOT WELDS" SAVE WEIGHT, DAMPEN VIBRATION IN FORD HOOD PANELS

As an improvement over conventional assembly methods, Ford Motor Company uses a neoprene adhesive to join the large 6-foot-wide outer hood panel to its reinforcing inner mate. Application is automated to simplify production. The multiple neoprene welds actually save weight. And best of all, resilient neoprene soaks up hood vibration and noise, completely eliminating the cost of asphaltic paper or mastic deadeners.

Ford automatically applies the 90 adhesive daubs. Inner panels are positioned and the edges hem welded. Air-dried on the way to the paint shop, the neoprene adhesive reaches a partial cure, which protects it from cleaning and phosphatizing chemicals. In paint ovens, the "spot welds" are completely cured. The adhesive's ability to adhere to oily metal and remain in position without slumping during paint bake exposures is chiefly responsible for the success of the new method.

This is just one of the many new structural application ideas in which neoprene adhesives can improve upon conventional joining methods. Special formulations for brush, spray or roller can bond rubber to plastic, plastic to plastic, plastic to metal, metal to metal—almost *anything* to *anything*. Ask your adhesives manufacturer about neoprene adhesives, or write E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department SAE-9, Wilmington 98, Delaware.

DU PONT

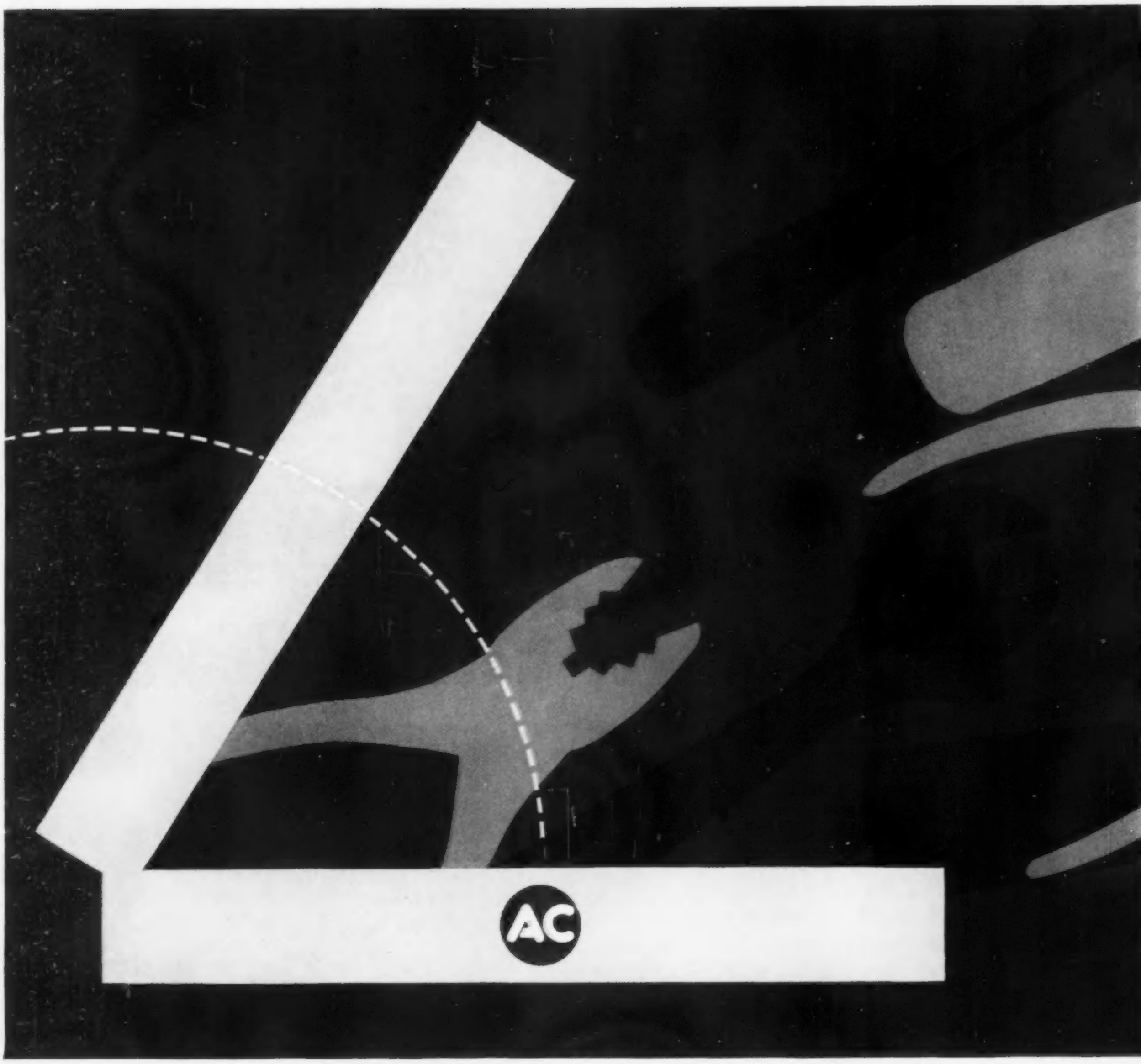
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER

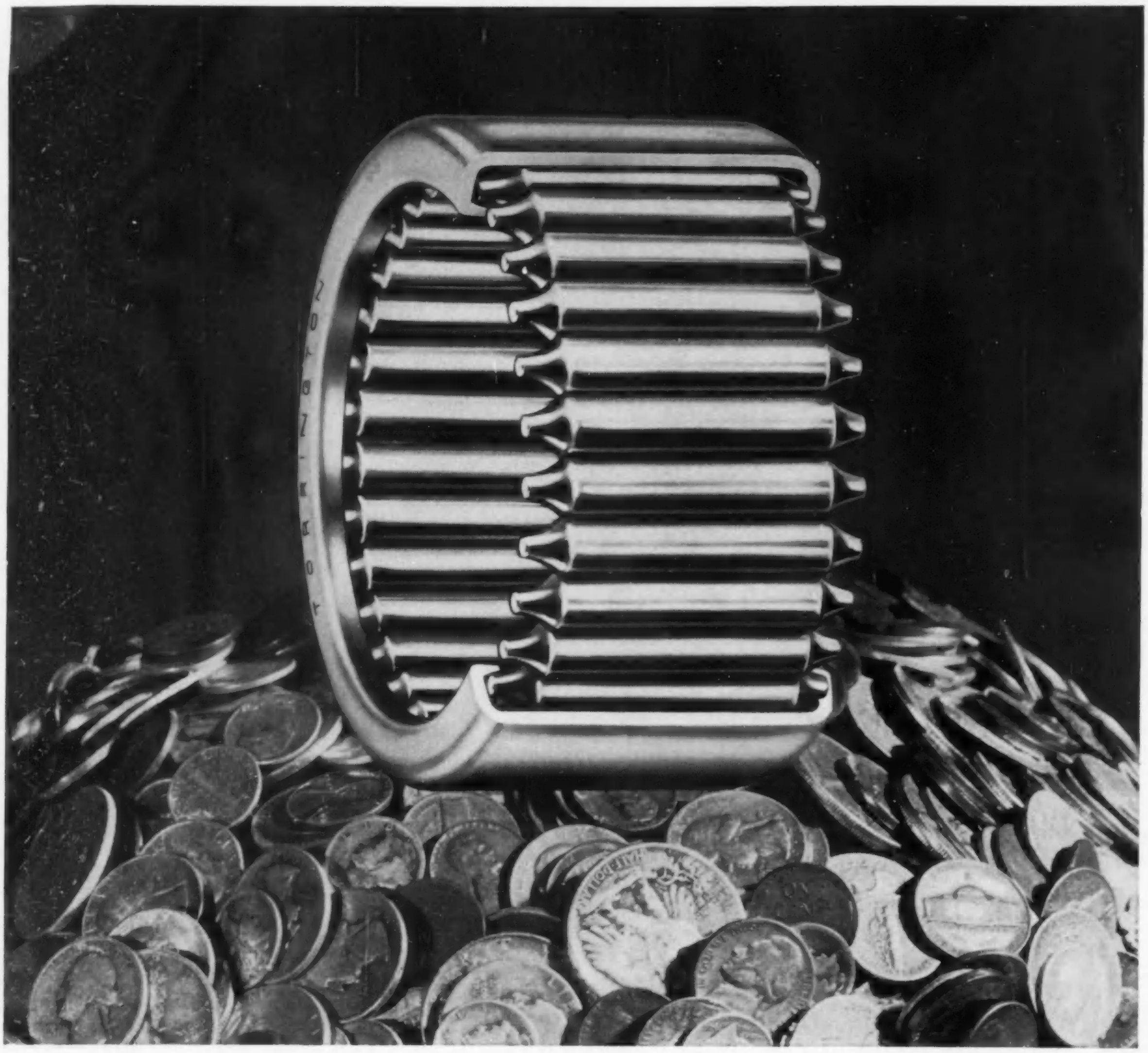
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

. . . THE CASE FOR AC .



Like a complete tool case . . . AC houses the skilled manpower and facilities that can be your tools for designing and building better products . . . with less effort!



Savings Pile Up
With Torrington Needle Bearings

You get performance-plus at a low, low unit cost when you specify Torrington Needle Bearings. A full complement of small-diameter rollers provides a maximum number of contact lines. The result—a higher radial load capacity at a lower unit cost than any other bearing of comparable size or performance.

Precision rollers operate smoothly and efficiently, with a low coefficient of starting and running friction. Positive roller retention is insured by turned-in lips on the outer shell, permitting faster and easier installation or assembly.

Your Torrington representative is an expert on Needle Bearings. For full information on how they can bring savings and improved product design and performance call Torrington—maker of every basic type of anti-friction bearing.

TORRINGTON NEEDLE BEARINGS FEATURE:

- Full complement of retained rollers
- Unequalled radial load capacity
- Low coefficient of starting and running friction
- Low unit cost
- Long service life
- Compactness and light weight
- Runs directly on hardened shafts
- Permits use of larger and stiffer shafts

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY Torrington, Conn. • South Bend 21, Indiana

SAE JOURNAL

For Sake of Argument

Compromise . . .

COMPROMISE to achieve something is worth while. Compromise to avoid something is usually unrewarding.

Compromise to appease a person, for example, rarely results in stability and progress . . . either for the appeaser or the job he's trying to get done.

But compromise to satisfy an existing condition or environment is something else again. It may permit immediately satisfactory production within the limits of existing buildings, equipment, or personnel. The compromiser need not forego continued search for ways to achieve the new buildings, new equipment . . . or even new personnel. He can still keep alive a movement toward finally optimum methods. Indeed, the longed-for optimum may be brought closer by compromise with the present than by a Gibraltar stance.

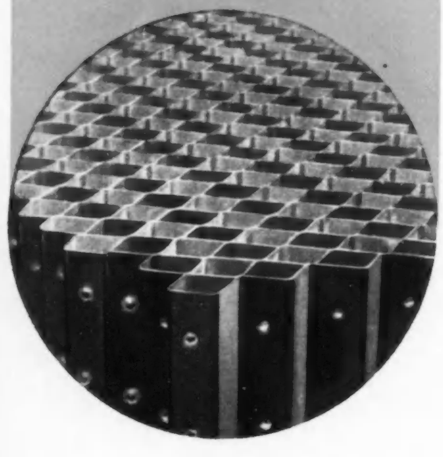
Compromise can play a constructive role in executive action as well as in design decisions.

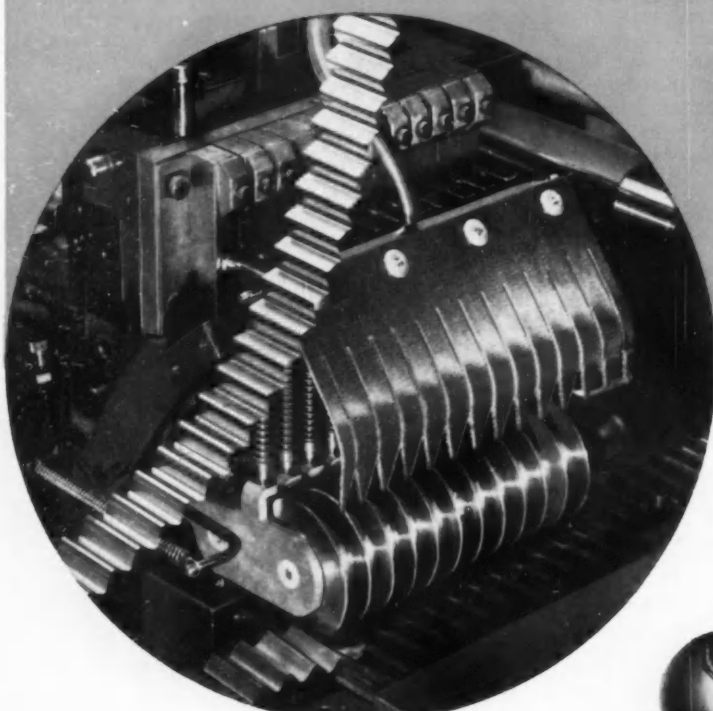
Unlike the politician, the industrialist has to make decisions which result in action . . . many times every day. A Berlin stalemate isn't possible in a company argument about whether or not to go to a front-wheel drive in 1961.

But it's all too easy for a business discussor to be proud of his opposition to compromise. Pride may lead to sticking to an opinion instead of a fact . . . to a platitude instead of a principle.

All parties to intraplant discussions are committed to the company's common goal. There, fear of compromise may arise from the essential strength or weakness of a proposed program. A thoroughly sound plan usually can be exposed to the pressures of compromise in such a group without emasculation resulting. Compromise has strengthened as many good plans as it has hurt.

Norman G. Shidle





NOMINEES FOR 1961 SAE BOARD OF DIRECTORS

President .... **A. A. KUCHER**
Vice-President, Engineering and Research, Ford Motor Co.

Treasurer .... **G. A. DELANEY**
Detroit, Michigan

DIRECTORS

One-Year Term (1961)

P. C. ACKERMAN
Vice-President—Engineering, Chrysler Corp., Engineering Div.

R. H. ISBRANDT
Director of Automotive Engineering and Research, American Motors Corp.

A. L. KLEIN
Professor of Aeronautics, California Institute of Technology; Consultant to Senior Vice-President of Engineering, Douglas Aircraft Co., Inc.

G. J. LIDDELL
Assistant to Manager, Product Development, Sun Oil Co.

Two-Year Term (1961-62)

W. F. FORD
Assistant Director, Petroleum Products Div., Research and Development Department, Continental Oil Co.

M. L. FREY
Assistant to General Works Manager, Tractor Manufacturing, Allis-Chalmers Manufacturing Co.

M. F. GARWOOD
Chief Engineer—Materials, Chrysler Corp., Engineering Div.

M. J. KITTLER
Executive Vice-President, Holley Carburetor Co.

E. J. MANGANIELLO
Associate Director, National Aeronautics & Space Administration

F. R. McFARLAND
Executive Assistant Chief Engineer, Buick Motor Div., General Motors Corp.

R. R. ROBINSON
Assistant Director of Research, Caterpillar Tractor Co.

Three-Year Term (1961-62-63)

P. F. ALLMENDINGER
Chief Engineer, Instrument Div., Stewart-Warner Corp.

J. H. DUNN
Manager, Alcoa Process Development Laboratories, Aluminum Co. of America

J. T. DYMENT
Chief Engineer, Engineering Department, Trans-Canada Air Lines

H. L. HIBBARD
Senior Vice-President, Lockheed Aircraft Corp.

O. K. KELLEY
Technical Assistant to General Manager, Defense Systems Div., General Motors Corp.

R. C. NORRIE
General Manager, Kenworth Motor Truck Co., Div. of Pacific Car & Foundry Co.

T. L. SWANSEN
Vice-President, Ladish Co.

If elected, the above members will serve on the 1961 SAE Board of Directors

★ ★ ★

Also serving on the 1961 Board of Directors will be:

One-Year Term (1961)

Following were originally nominated as Councilors for two years; but, under the amended Constitution and By-Laws they were elected to serve as Directors for two years, 1960-61:

L. C. KIBBEE
Director—Engineering Department, American Trucking Associations, Inc.

***A. A. KUCHER**
Vice-President, Engineering and Research, Ford Motor Co.

J. R. MacGREGOR
Vice-President and Director, Charge, Petroleum Products Research, California Research Corp.

PAST-PRESIDENTS:

H. E. CHESEBROUGH
Vice-President, Chrysler Corp. and General Manager, Plymouth-De Soto-Valiant Div.

LEONARD RAYMOND
Chief Automotive Engineer—Research, Socony Mobil Oil Co., Inc.

*** If elected to the Presidency, replacement to be selected by the 1961 Board of Directors**

chips

from SAE meetings, members, and committees

USE OF UNITIZED BODIES on the smaller Falcon and Comet has resulted in a lower hourly production rate at Ford's Lorain assembly plant — as compared to that of the larger standard Ford cars previously assembled there.

AT NEW YORK AND LONDON AIRPORTS the use of silencers and of noise abatement take-off procedures has reduced the take-off noise of the current jet aircraft to a level where complaints concerning the approach noise has become equally numerous. At Los Angeles, most take-offs are made over water and it is the approaches over land which disturb most.

POINT-TO-POINT DRILLING is a promising application for tape-controlled equipment in the job shop. Manual operation has resulted in up to 30% scrap losses on precision parts. Automatic control eliminates both inspection and scrap loss.

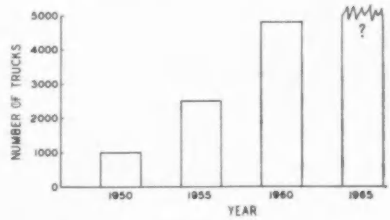
"MUSKEG" COSTS CANADIAN oil operators a pretty penny. They have a big stake in bettering transportation of tonnage over the "muskeg" areas where much mineral wealth is to be found. ("Muskeg" describes a wide range of terrains found in poorly drained Canadian Northland and peat-bog areas of the world in general.)

Muskeg occurs in various difficult forms over an estimated 320,000,000 acres in Canada; 25% of the prospective oil land in Canada is muskeg-covered.

Since 1947, the oil industry has cut 180,000 miles of trails for exploration purposes. Geophysical crews have profiled over 250,000 miles using those trails, at an estimated cost of $150,000,000. *The cost of deep tests in muskeg areas is about 2½ times the cost of similar tests at plains locations* . . . and part of the increased cost can be traced to expensive transportation over muskeg. . . . Of the $415,900,000 projected for final exploitation cost of the Pembina field, about $25,000,000 to $30,000,000 are directly attributable to muskeg.

IN AN OPTIMIZED cam design solution, about 150,000 to 200,000 arithmetic calculations are required. By desk calculator methods, these would take about 75 man-months. So, concluded a Willys-sponsored group of experts at SAE's Summer Meeting last month, electronic computer programming is a *necessity*. An IBM 650 computer, they said, can do the job in 3 hr; the IBM 704 computer, in about 20 min.

SINCE 1947 A COMMON LUBRICANT has been used for transmissions and axles of some heavy-duty equipment . . . and the number of vehicles using it has steadily increased through the years. The accompanying graph, for example, shows the number of heavy-duty trucks in seven Western states that use a common lubricant. The tremendous increase during the 1955–1960 period is the result of increased acceptance of this practice by manufacturers and truck lines, and of tremendous expansion by a relatively few very large lines.



SPACE-AGE DICTIONARY

- **soft launching site** — missile launching site not specifically designed to withstand the blast, ground shock, heat, or radiation effects of a nuclear or thermonuclear explosion.

- **hard launching site** — a site designed to withstand blast, ground shock, heat, and radiation caused by a specific warhead megaton yield and within a specified overpressure.

PASSENGER VEHICLES WITH TRAILERS had an accident rate 2.8 times as high as passenger cars alone, during a six-year period on the New Jersey turnpike. Trucks, as a group, were 70% higher and buses were 10% below the passenger-car rate.

Creativity is a quality of a person; not of the job he holds.

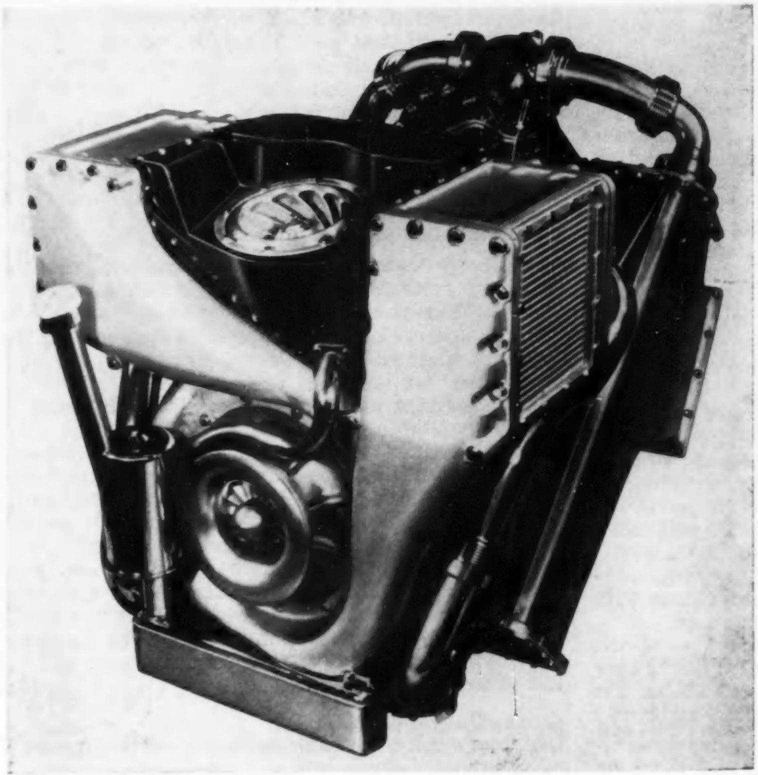


Fig. 1 — **FORD'S NEW MODEL 704 GAS TURBINE** packs 300 hp in compact form for application in heavy-duty trucks.

Ford develops gas turbine for trucks

Compact engine gives excellent part-load performance. With further refinement, it might surpass the diesel in fuel economy

Based on paper by

I. M. Swatman and D. A. Malohn

Ford Motor Co.

A GAS TURBINE which weighs a little more than 2 lb per hp and shows excellent fuel economy at part-load has been developed by Ford for installation in heavy-duty trucks. With improvement in the efficiencies of rotating aerodynamic components, fuel capacity excelling that of current diesel engines is anticipated. The engine, designated as model 704, is shown in Fig. 1. The configuration is shown in Fig. 2.

In the course of developing this engine, an intensive investigation was made of different turbine cycles from the single-spool with recuperator to the two-spool with intercooling, recuperator, and reheat after the high-pressure turbine. In all, 10 cycles were studied with the one omission of the variable-geometry engine. This was omitted because variable-geometry in a centrifugal compressor is not enticing and the axial compressor is too costly at the present state of the art.

As the result of a design-point study, a two-spool, intercooled, regenerative, reheat cycle, was selected as the best for a more detailed part-load investigation. The specific horsepower of this cycle appeared to approach a maximum at an overall pressure ratio of 16/1 and the specific fuel consumption appeared to be relatively flat from a pressure ratio of 7/1 to 16/1.

Part-load studies were undertaken following design-point sizing of the aerodynamic components. In general, the part-load fuel consumption with decreasing load will vary much as design-point studies do with decreasing pressure ratio. The cycle chosen did not follow this axiom and part-load studies were unexpectedly discouraging in that the fuel consumption increased as load was reduced at an even more rapid rate than occurs with a low-pressure cycle engine. It was then found that the location of the power turbine resulted in the low-pressure spool turbines absorbing most of the available gas energy at part load, thereby maintaining

Ford develops gas turbine for trucks . . . continued

a high compressor speed and airflow. This characteristic resulted in load control by rapid reduction of cycle temperature. Operation in the part-load range was analogous to a machine with a single-stage compressor. The power turbine was then placed ahead of the low-pressure compressor turbine, with significant results.

The effect of allowing the power turbine to absorb most of the available gas energy changed the operating characteristics of the low-pressure spool speed, resulting in an independent speed relationship between the high-pressure and low-pressure compressors. The near constant-speed feature of the high-pressure spool, combined with an almost constant reheat-burner temperature and varying air-flow characteristics (for varying power requirements) of the low-pressure spool, produced excellent part-load fuel economy. This arrangement attains minimum fuel consumption at 50% load. In addition, it was believed that the high idle speed and almost constant speed of the high-pressure spool above 30% load would result in improved acceleration.

The studies indicated that an engine using the modified cycle would result in a specific power output of 130 hp/lb-air/sec when compared with the low-pressure regenerative engine whose capability appeared limited to about 65 hp/lb-air/sec. At 50% load, the cycle would attain a fuel specific of 0.395 lb/hp/hr compared with 0.75 lb/hp/hr for the low-pressure regenerative engine. Moreover, with twice as much power per pound of airflow in favor of this cycle, a very compact powerplant could be obtained, and since the recuperator effectiveness assumed was only 75%, a very compact, plate-type, heat exchanger appeared to be feasible.

Finalizing the configuration

Before proceeding with an engine design, estimates of pressure loss were made and totalled at 21.97%. For power steering, generator, air conditioning, and air brake compressor requirements the estimate was 16.8 hp. Design-point operating pressures and temperatures are presented in Table 1 and correspond to the stage locations indicated in Fig. 2.

Fuel consumption attainable from an installed 704 engine with engine-driven accessories is shown in Fig. 3. At 50% load it requires 0.48 lb/hp/hr of fuel in contrast with 0.76 lb/hp/hr for a low-pressure, 90% effective, regenerative engine (curve 1A) when rated at the same ambient, inlet, and exhaust pressure loss and same accessory load. With concerted effort to improve efficiencies of rotating aerodynamic components 2% over those assumed in cycle studies, fuel economy can surpass the present diesel engine.

To Order Paper No. 187A . . .
from which material for this article was drawn, see p. 6.

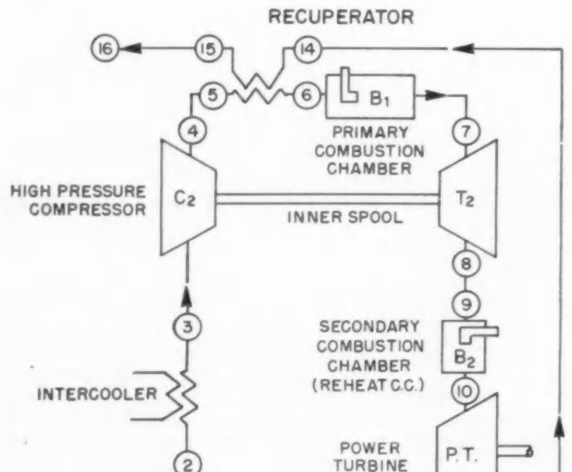


Fig. 2 — Cycle configuration of Ford 704 automotive gas turbine.

Table 1 — Design-Point Operating Pressures and Temperatures of Model 704 Gas Turbine

Station	P_t, psia	T_t, R
0. Inlet — Silencer	14.70	560
1. Inlet — Low-Pressure Compressor	14.45	560
2. Inlet — Intercooler	57.80	896
3. Inlet — High-Pressure Compressor	56.00	682
4. Exit — High-Pressure Compressor	223.98	1085
5. Inlet — Recuperator	221.74	1085
6. Inlet — Primary Combustion Chamber	220.97	1426
7. Inlet — High-Pressure Compressor Turbine	212.13	2160
8. Exit — High-Pressure Compressor Turbine	84.57	1795
9. Inlet — Secondary Combustion Chamber	83.89	1795
10. Inlet — Power Turbine	81.37	2160
11. Exit — Power Turbine	39.89	1864
12. Inlet — Low-Pressure Compressor Turbine	39.57	1864
13. Exit — Low-Pressure Compressor Turbine	15.92	1539
14. Inlet — Recuperator	15.92	1539
15. Inlet — Exhaust Pipe	15.05	1203
16. Exit — Exhaust Pipe	14.79	1203
Mass Flow, lb/sec	2.71	
Drive Shaft, hp	300	
Drive Shaft Specific Fuel Consumption lb/hp/hr	0.566	
Fuel Flow — Primary Combustor, lb/hr	112.7	
Fuel Flow — Secondary Combustor, lb/hr	57.0	
Fuel Flow — Total, lb/hr	169.7	

Excerpts from discussion . . .

By **William A. Turunen,** General Motors Corp.

The data presented in Fig. 4 show that fuel consumption differences between the 704 cycle and the low-pressure, regenerative cycle at part-throttle are considerably less than indicated in Fig. 3. The upper solid curve of Fig. 41 is actual test data from the GT-305 engine; the lower solid curve is from the advanced version of the engine. It will be interesting to contemplate the actual differences when test data from the two cycles are compared.

By **W. T. von der Nuell,** Garrett Corp.

When using specific fuel consumption as a yardstick, would not ton-miles per time unit per Btu be more realistic than lb per hp per hr? This, aside from initial cost, maintenance, and the like, is what counts in profitable trucking. The other important conditions for vehicles deserve close scrutiny — acceleration and deceleration, the latter depending greatly upon the so-called braking characteristics of the engine. What has been termed "variable flow geometry" may be a means of influencing these characteristics of gas turbines to a high degree.

Authors' reply to discussion . . .

While Mr. Turunen's data look impressive, there is no indication of the ambient conditions and inlet and exhaust pressure losses under which this performance was achieved; also, whether any accessory load is considered.

The curve in Fig. 3, we would like to emphasize, is the fuel economy attainable from an installed engine operating at 100 F ambient with an all accessory load, that is, airbrake compressor, power steering pump, and generator. As we stated in the text of our paper, we penalized the Ford engine 16.8 hp for these losses in the cycle studies. By comparison, if the losses are disregarded, the Ford 704 cycle engine has a fuel economy of less than 0.4 lbs per bhp-hr at 50% load.

While Dr. von der Nuell's suggestion for arriving at a more realistic method of computing cost of vehicle operation appears intriguing, instigating its adoption by the trucking industry would, undoubtedly, be a difficult task, particularly since the trucker, as a potential customer for the gas turbine powerplant, is obviously going to require fuel economy parameters for the gas turbine, which he can directly compare with known fuel economies for the engines that he is now using.

With regard to acceleration, the arrangement of the Ford 704 power turbine ahead of the low-pressure spool turbines allows variations in the turbine design that have resulted in improved acceleration of the compressor-turbine spool, with resultant overall improvement in engine acceleration characteristics. Deceleration is a different story. This can be accomplished aerodynamically, but from design study it appears that the cost will offset the advantages. A number of very attractive transmission retarders are, however, available for this purpose and appear to be the best solution economically.

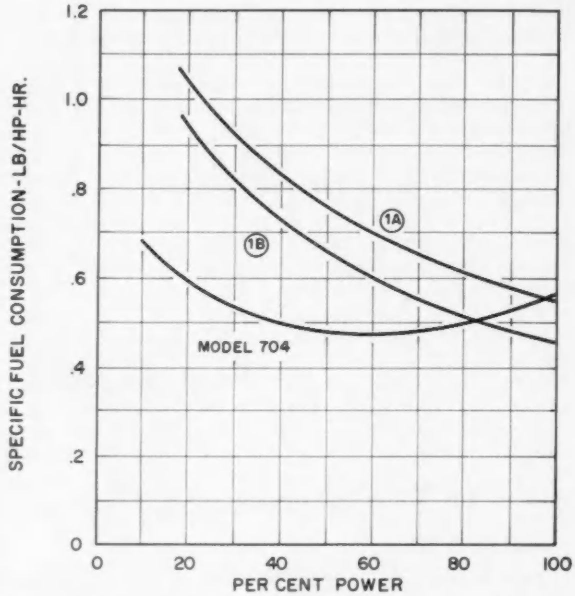


Fig. 3 — Comparative part-load performance shows superior fuel economy of the model 704 when contrasted with a low-pressure, 90% effective, regenerative engine (1A).

Curve 1A = Cycle for single spool with recuperator at 100 F inlet air temperature, with accessory load, inlet and exit loss same as for 704 gas turbine engine

Curve 1B = Cycle for single spool with recuperator at 60 F inlet air temperature, without accessory load, inlet and exit loss

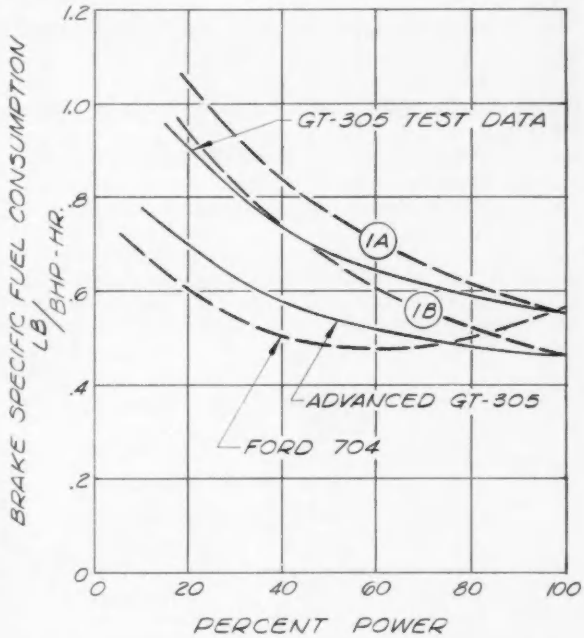


Fig. 4 — Comparative part-load performance of Ford 704 and General Motors GT-305 gas turbines. This chart should be compared with Fig. 3.

4 different coating steel with

Four leading companies tell how they apply

1. The Marvibond Process

The Marvibond process is a high-speed method for producing metal-vinyl laminate on a continuous basis (Fig. 1). Adhesives are used to bond the vinyl sheeting to the metal.

The process starts with a chemical cleaning and rinse of the base metal. This removes all contaminents which could cause failure of the adhesive bond. A conversion coat of metallic phosphate is then applied to the metal. These phosphating solutions react with the metal surface to form a coating which becomes an integral part of the surface and which forms the base for a strong adhesive bond. The final metal treatment is a 1% chromic acid rinse to provide rust resistance to the cold rolled steel.

The metal preparation procedure varies somewhat for galvanized steel, aluminum, copper, and brass — but all have the same objective, a clean metal which will permit a satisfactory adhesive bond.

After the metal has been properly prepared, it is ready for the adhesive coat. The adhesive, either thermoplastic or thermosetting, is applied to the metal by spraying or roller coating. The roller coating technique is better suited to high-speed production lines since there is less chance for air entrainment and nonuniform deposition of adhesive. Experience has shown that best results are obtained when the dry adhesive film is $\frac{1}{4}$–$\frac{1}{2}$ mil.

Since the adhesives contain about 20% solids, the solvents must be driven off before lamination can take place. This is done by passing the coated metal through an oven heated to about 250 F. This is followed by another oven treatment which brings the surface temperature of the metal to 375–425 F depending on the variables of the process, such as speed, metal type and thickness, and type of adhesive.

As the hot sheet emerges from the oven, the vinyl sheeting is pressed against it, and the vinyl and metal go through a pair of rubber combining rolls. Emerging from the combining rolls, the laminate is quickly cooled by water or air. When the excess vinyl has been trimmed from the sheet, the laminate is ready for use. These laminates can be supplied in long coils or in sheets precut to size.

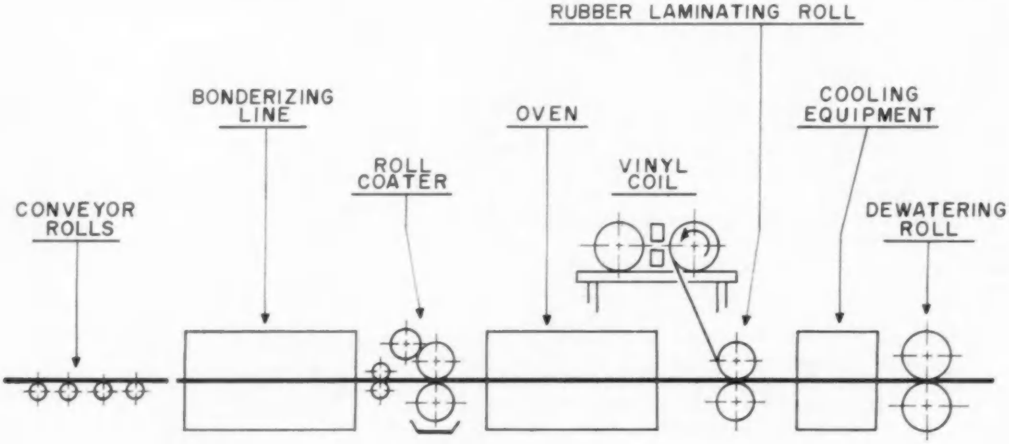


Fig. 1 — Marvibond laminating line.

ways of

plastics

vinyl coatings to steel.

The Marvibond process of applying vinyl to metal presents a number of advantages. The composition of the sheeting can be made flexible, semi-rigid, or rigid. Any combination of printing and embossing can be put on the vinyl. And, complete quality control testing of the vinyl to insure proper thickness, composition, color, printing, and embossing can be performed before committing the metal.

Typical physical properties of Marvibond vinyl sheeting include:

Tensile strength	3000 psi
Modulus at 100%	2300 psi
Graves tear strength	600 lb per in.
Ultimate elongation	160%

Bond strengths between the vinyl and the metal run over 20 lb per in.

Forming operations that can successfully be performed on these laminates include shearing, crimping, punching, drilling, brake-press bending, stamping, roll forming, and cold drawing. Draft on deep draws is the same as required for the base metal alone. A clearance of about 0.003 in. should be allowed over the thickness of the laminate. Lubrication during forming should be of the water soluble type so that the surface of the vinyl can be easily cleaned by a water rinse. Blanking and piercing operations will expose the bare metallic core on the sheared edges. To prevent rust or corrosion, or to improve their appearance, these edges may be painted or covered by inserts or moldings.

When it comes to welding vinyl-metal laminates, ordinary flame welding, brazing, or soldering cannot be used since the vinyl surface will be destroyed. However, special welding techniques using high voltage and split-second welding cycles have been developed which make it possible to affect welds without damaging the vinyl film.

2. Whirlclad Fusion Bond Coatings

The Whirlclad coating system is based on coating by dipping a preheated object into a bed of finely divided, dry, fluidized powders which melt and fuse on the heated surface to form a continuous, uniform film.

After suitable surface preparation, the parts to be coated are preheated in an oven to a temperature above the melting point of the fusion bond coating to be applied. The preheat temperature depends upon the type of plastic used, the thickness of coating to be applied, and the shape, mass, and substrate of the article to be coated.

After preheating, the parts are immersed with appropriate motion in the fluidized bed. The plastic powders are fluidized by an ascending current of air or gas in the tank that contains the powders. These powders appear and feel like a liquid in this suspended state. In fact, if the tank is tipped or rocked the level of the fluidized powder moves and changes as the level of a liquid.

As the powder particles contact the heated part they fuse and adhere to the surface. After the removal from the fluidized bed, often, the part is briefly postheated to completely fuse the coating and to obtain the best surface appearance.

The thickness of the coating applied depends on the temperature of the part surface, a result of the time and temperature of preheat, and the time of immersion in the fluidized bed.

With the Whirlclad process, it is possible to apply a controlled uniform thickness of coating without the use of solvents from 5–50 mils in a single dip. Since dry plastic powder is used and only becomes molten briefly during the coating process, uniformity of coating is a characteristic of the process even over sharp edges. Fusion bond finishes when properly applied are unmarred by sags, drip marks, pock marks, bridging, or surface irregularities.

Solvent resistant plastics such as nylon, polyethylene, chlorinated polyethers, and fluorocarbons can be applied by this process since no solvents are used. Parts made with these coatings can be machined to close tolerances.

Minimum surface preparation is required for a quality fusion bond finish. Usually hot alkaline degreasing, to remove grease and oil from the part surface, followed by water rinse is sufficient. To obtain maximum adhesion and underfilm corrosion resistance if the film is broken in service, the degreased part is primed using a low viscosity solvent type primer.

Relatively short coating cycles per part are possible since multiple handling, multiple coat application, and usually post curing or baking requirements are eliminated. Thus a typical cycle would be as follows:

Degreasing and priming	5 min
Preheat time	5 min
Immersion time (in the fluidized bed)	10 sec
Postheat time	2 min
Cooling time	5 min

Among the substrates being coated by this process are steel, stainless steel, cast iron, aluminum and zinc alloy die castings, copper, bronze, brass, and

VINYL COATING LINE FACILITIES

coating steel with plastics

. . . continued

glass. Six basic types of plastic fusion bond finishes are commercially available. These are cellulosic, vinyl, epoxy, nylon, polyethylene, and chlorinated polyether.

3. The Kaybar Process

The Kaybar process bonds vinyl to steel. But rather than apply the vinyl to the steel in strip or sheet form, vinyl is applied in liquid form and cured in place after all fabrication has been completed. The steel is fabricated with any desired pattern embossed. The vinyl reproduces the basic texture of the steel part in thicknesses from 0.002–0.020 in. or more.

The development of a finished product using the Kaybar process follows this sequence:

1. The pattern and texture depth is chosen to fit the product.
2. Steel is procured from the mill with the pattern embossed on either one or both faces. Pattern depth is specified and will range from 0.002–0.007 in. or more.
3. The embossed steel is blanked and formed into the finished part just as though it were conventional steel stock.
4. Any necessary assembly operations, such as welding, cementing, and crimping are performed. Welding is done with conventional equipment and cycles.
5. Parts are inspected at this point and any rejects are eliminated prior to coating.
6. Cleaning, priming, and finished coating operations.
7. Final inspection and packaging or transfer to final assembly.

In the steel fabrication, normal blanking, stamping, and welding techniques can generally be used.

The vinyl coating may be applied in thicknesses to suit the application. For decorative surfaces where moderate abrasion is incurred, 0.003–0.004 in. should suffice; for heavy abrasion areas 0.008–0.010 in. would be desirable; for exterior, heavy service, film thicknesses to 0.020 in. or more can be used.

The first step in the coating process is to clean the metal surface. Production is now being run in both two and three-stage washers using 1–2 oz of detergent cleaner in the first stage with a small amount of iron phosphate added to prevent the possibility of rusting prior to priming. This is followed by a warm, running rinse in clear water. Most parts are of sufficient mass that additional heating will be required to remove the excess water. So, a hot air blowoff should immediately follow the last rinse.

After washing and drying, a primer coat is applied to areas requiring coating. This primer is thermosetting and should be applied in very thin films. A uniform coating of ¼ mil provides good adhesion. Primer application is by hand spray or electrostatic operation. The primer is baked at 400–425 F for 5 min.

The vinyl film is applied in the color and thickness required. This is done by hand or by electrostatic equipment. For light films (2–3 mils), the material is applied in one heavy wet pass or in two consecutive passes, one immediately following the other. On heavier film builds, it is desirable to apply 2–3 mils and then allow 1 min air dry time, prior to the next 2–3 mil film. After the final vinyl coat, an air dry of 5–7 min relieves a large percentage of the solvents. A low bake at approximately 200 F for 5–7 min completes the solvent removal.

From the low bake stage, the work goes directly to the curing oven (350–360 F) for approximately 12 min. This time depends on the mass of the part being processed. Upon cooling, the finished part is ready for final inspection and packaging.

4. The U. S. Steel Process

In the plastisol process used by U. S. Steel, liquid vinyl is applied to steel that has been coated with an adhesive primer. In this process, the vinyl film is created on the steel as a continuous coating that may be decorated after the coating has been cured. Cold-rolled steel, galvanized, and aluminum-coated steel may be vinyl coated with this process.

A flow diagram of the process is shown in Fig. 2 Steel is passed through an electrolytic cleaner, where all traces of foreign material are removed from the surface. The cleaned steel then passes through the electrochemical treating unit, where the steel surfaces receive a thin deposit of a chromate-phosphate type of film. Next, the top side of the steel is coated with a thin film of thermosetting adhesive primer applied by a roller coater. A second roller coater applies a protective coating on the bottom or reverse side of the steel. (This step may be eliminated if reverse side protection isn't needed.) The coatings on both sides of the steel are cured simultaneously by heating to a suitable temperature.

After the adhesive-coated steel is cooled, it passes through another roller coater, where plastisol is applied to the top surface of the sheet to provide a coating of the desired thickness, normally from 8 to 20 mils. The vinyl coating is cured by a second induction heater that again raises the steel temperature rapidly to a proper value. This curing is supplemented by passing the coated metal through an embossing stand, where the desired pattern is impressed in the vinyl. After cooling, the product passes through an inspection station, equipped with a special lighting booth, where its color and quality are inspected. The finished product is then either coiled or cut to length.

The line is designed to process coils weighing up to 10,000 lb, with widths up to 52 in. and thicknesses from 16 to 32 gage.

Vinyl-coated steel can be deep-drawn (Fig. 3), stretcher-leveled, roller-leveled, sheared, blanked, stamped, and brake-formed without damage. Although the vinyl, under heavy pressure, may compress to about 60% of its original thickness, plastic recovery causes it to spring back rapidly.

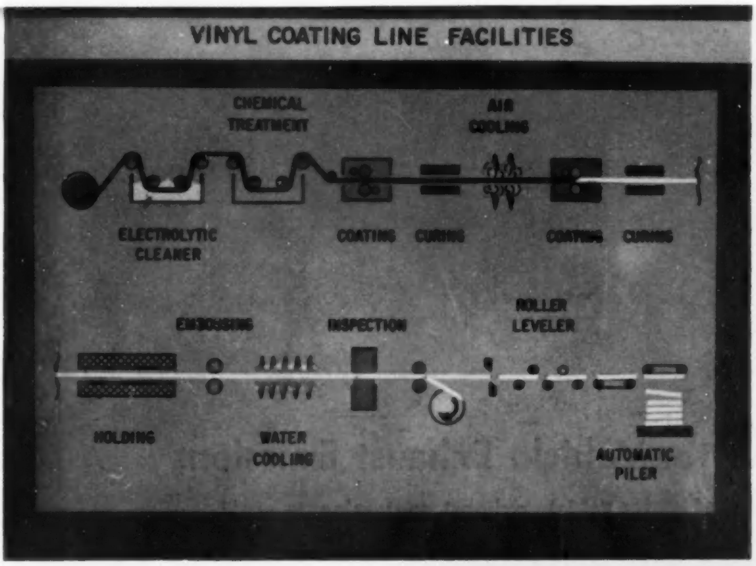


Fig. 2 — U. S. Steel process for coating metal with vinyl.

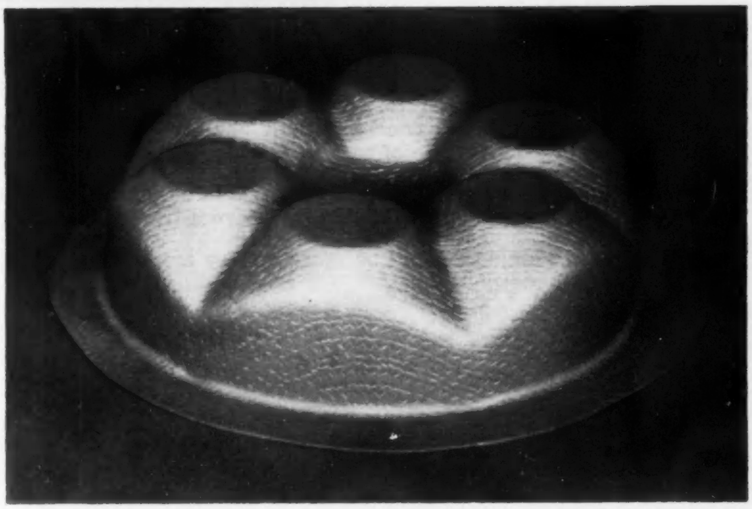


Fig. 3 — Typical deep-drawn vinyl-coated steel part.

VINYL-COATED STEEL is usually made by either the laminating process or the plastisol process. Both processes result in products with virtually the same characteristics.

In the laminating process, calendered vinyl film is applied to steel that usually has been coated with an adhesive primer. The Marvibond process is a laminating process.

In the plastisol process either dry or liquid vinyl plastisol is applied to steel that has been coated with an adhesive primer. Here, the vinyl film is created on the steel as a continuous coating. The U. S. Steel and Kaybar processes are liquid processes. The Whirlclad process is a dry, fluidized powder process.

This article describes these four processes. It is based on the following papers:

The Marvibond Process — Seven Years' Experience, P. E. ROGGI and C. E. KIERNAN, Naugatuck Chemical Division, U. S. Rubber Co., paper 180A.

Production and Application of Vinyl-Coated Steel, G. H. RENDEL, U. S. Steel Corp., paper 180B.

A New Approach to Vinyl Films on Steel, W. G. CRYDERMAN, Kaybar, Inc., paper 180C.

Fusion Bond Coatings — A New Technique for Plastic Cladding Metal, W. R. PASCOE, Whirlclad Division, The Polymer Corp., paper 180D.

To Order Papers No. 180A, B, C, D from which material for this article was drawn, see p. 6.

TABLE I

Standards for Motor Vehicle Exhaust Emissions

THE STANDARDS of emissions of motor vehicle exhaust contaminants are:[a]

HYDROCARBONS — 275 parts per million by volume as hexane (0.165 mole per cent carbon atoms)

CARBON MONOXIDE — 1.5% by volume.

The standards refer to a composite sample representing the driving cycle described below. Exhaust gas concentrations shall be adjusted to a dry exhaust volume containing 15% by volume of carbon dioxide plus carbon monoxide.

Hydrocarbons are defined as the organic constituents of vehicle exhausts as measured by a hezane-sensitized nondispersive infrared analyzer or by an equivalent method.

Carbon monoxide shall be measured by a nondispersive infrared analyzer or by an equivalent method.

Driving Cycle

Condition	Rate of Speed Change mph/sec	Per Cent of Total Time	Per Cent of Total Sample Volume
Idle	—	15.0	4.2
Cruise			
20 Mph	—	6.9	5.0
30 Mph	—	5.7	6.1
40 Mph	—	2.7	4.2
50 Mph	—	0.7	1.5
Acceleration			
0–60 Mph	3.0	1.1	5.9
0–25 Mph	2.2	10.6	18.5
15–30 Mph	1.2	25.0	45.5
Deceleration			
50–20 Mph	1.2	10.2	2.9
30–15 Mph	1.4	11.8	3.3
30– 0 Mph	2.5	10.3	2.9
		100.0	100.0

[a] It has been judged that an overall 80% reduction of motor vehicle exhaust hydrocarbon emissions is needed. The hydrocarbon concentration expressed in these standards was derived by applying this per cent reduction to the current estimated average exhaust hydrocarbon concentration.

It has been judged that an overall 60% reduction of motor vehicle exhaust carbon monoxide emissions is needed. The carbon monoxide concentration expressed in these standards was derived by applying this per cent reduction to the current estimated average exhaust carbon monoxide concentration.

In the application of the standards to the approval of exhaust control systems, consideration must be given to such factors as warmup time, reliability, and effective life of control devices, and exemption of certain groups of vehicles from compliance. If a substantial number of vehicles are allowed to exceed the standards greatly the objective of the standards may not be reached.

California explains its

New Exhaust Standards

Based on paper by

G. C. Hass,

senior sanitation engineer
California Department of Public Health

CALIFORNIA has already set and approved "Standards for Motor Vehicle Exhaust Emissions" — which contain a "Driving Cycle" provision that "was developed for passenger vehicles and is not appropriate for truck and bus operation." (These standards were set up by California's Department of Public Health.)

STILL TO COME is issuance of certificates of approval for motor vehicle pollution control devices . . . . These approvals will be one function of a 13-man State Motor Vehicle Pollution Control Board, which, under a new California law, will eventually "control vehicle emissions."

HOW PERMANENT are the now-approved California exhaust emission standards?

Author G. C. Hass, senior air sanitation engineer, California Department of Public Health, answers this vital-to-industry query by saying:

"The law which required the setting of standards also provides for their periodic revision.

"The Department is aware of the difficulty in shooting at a moving target and will respect the need for a stable standard. It would be unthinkable, for example, to approve a system under the current standards, allow an industry to tool up for production and then after a short time adopt a tighter standard which would require withdrawal of approval.

On the other hand, if the data and hypotheses which underlie the current standards are shown to be seriously in error, it is imperative that the standards be corrected as soon as possible. These data and hypotheses are being tested, although at a much slower rate than we would wish.

"At the present time it is difficult to predict when the first two devices will be certified. If this period is long enough, it may be possible to make a first revision of the standards before the certification date. Otherwise, the standards might not be revised for a number of years, after which the new standards would be applied to new installations, while existing devices were 'grandfathered.'

"The recent special session of the California Legislature gave the Department of Public Health additional authority to consider other sources of vehicular emissions than exhaust. Consideration is being given to the establishment of standards for such emission points as crankcase vents, carburetors, and fuel tanks."

*

TWO "INDEXES" formed the basis for the motor vehicle exhaust standards (Table 1) set up recently by California's Department of Public Health . . . . as required by a 1959 California law.

Subsequently, the California legislature passed a bill that will eventually require control of vehicular emissions . . . . and will require the State controlling agency to consider in such approval these standards (along with other criteria on such factors as cost, durability, ease of inspection, and any other factors that the "control" agency considers pertinent).

To establish these motor vehicle exhaust standards, the California Department of Public Health first set up standards for air quality . . . . in which it distinguished three "levels of concern," as follows:

ADVERSE level	— level at which there will be sensory irritation, damage to vegetation, reduction in visibility, or similar effects.
SERIOUS level	— level at which there will be significant alteration of bodily function or which is likely to lead to chronic disease.
EMERGENCY level	— level at which it is likely that acute sickness or death in sensitive groups of people will occur.

The first two of these air quality level definitions formed the basis for the motor vehicle exhaust standards (Table 1).

At the ADVERSE Level, was established an "Oxi-

dant Index" of 0.15 parts per million for one hour by the potassium oxide method.

At the SERIOUS Level, was established a "Carbon Monoxide Index" of 30 ppm for eight hours.

The carbon monoxide air quality standard was relatively easy to translate into a corresponding standard for motor vehicle exhaust emissions. Translation of the oxidant-index air quality standard was much more difficult.

Translation of the carbon monoxide air standard was made on the basis of specific, translatable data such as:

- Construction and extrapolation of a source inventory to the year 1970 as a design date. (The source data indicate that, for practical purposes, the only significant source of atmospheric carbon monoxide is motor vehicle exhaust.)
- Medical judgment of a level of significant impairment of important bodily function in a sensitive segment of the population . . . in people with impaired respiratory or circulatory capacity.
- The atmospheric concentration of carbon monoxide in Los Angeles on days of poor ventilation — which is a matter of record.
- Calculation of the reduction in source strength needed to attain maximum concentrations below the standard. (A 60% reduction in carbon monoxide concentrations was indicated.)

But translation of the air quality standard was more complex. This air quality standard refers to substances which do not appear in motor vehicle exhaust . . . . but which have their origin in the action of sunlight on materials emitted from motor vehicle exhausts and from other sources as well. So, quantitative relationships must be considered between these photochemical products and the concentrations of the primary pollutants. *The present state of knowledge is such that conclusions must be labelled hypothetical.*

Experimentation has been seriously limited by the difficulty in quantitative measurement of biological effects caused by unknown substances. Nevertheless, experiments in irradiation chambers with human subjects and test plants have provided much useful information. These experiments have consistently shown the particular importance of olefinic compounds in the production of eye irritation, vegetable damage, and photochemical aerosol formation. They have also shown an apparent dependence of the reactions on the ratio of organics to nitrogen oxides.

Some caution in interpretation of these experiments is dictated by the fact that it has generally been found necessary to use somewhat higher concentrations of pollutants than those naturally occurring to duplicate the atmospheric smog effects. *The reasons for this discrepancy are not fully understood.*

In producing smog products, nitrogen oxide is the primary energy acceptor in initiating the photochemical reactions.

The crucial assumption concerning smog mechanism made in the development of these "Standards for Motor Vehicle Exhaust Emissions" may be stated as follows:

> The maximum concentrations of eye irritants, "typical oxidant" phototoxicants, and the photochemical aerosol which can be developed in a polluted atmosphere are proportional to the initial concentration of olefins.

Accordingly, the significance of various sources was evaluated in terms of olefin emissions.

By this scale, motor vehicle exhaust is by far the greatest source in Los Angeles County. It was concluded that 80% reduction in exhaust olefins should be required. Since field survey data on vehicle emissions are expressed in terms of hydrocarbons as measured by hexane-sensitized infrared analyzers, the standard is expressed in terms of hydrocarbons instead of olefins.

These exhaust standards do not include a value for oxides of nitrogen. Reasons:

- Air quality standards do not call for a reduction in nitrogen dioxide as a toxic substance *per se*. . . . . So, an exhaust standard must be justified on the basis of involvement of nitrogen oxides in the photochemical reactions.
- Experimental evidence indicates that control of olefins alone will markedly reduce the smog effects of eye irritation, oxidant plant damage, and haze.
- Evidence also indicates that reduction of ambient air ozone concentrations to levels as low as 0.1 ppm would traditionally require reduction of nitrogen oxides and organics other than olefins. (Present air quality standards do not require such an ozone reduction.)
- Possibly, future air quality standards for ozone and nitrogen oxides will require a corresponding oxide of nitrogen exhaust standard.

Translating the desired overall vehicle emission standards into an emission standard for individual vehicles introduces additional difficulties and uncertainties.

Emissions are widely variable as functions of traffic pattern, driving habits, make and condition of vehicle, and testing procedure.

The most comprehensive study of vehicular emissions in Los Angeles was conducted by the Coordinating Research Council in 1956. Results of this survey have apparently satisfied no one as being a final answer.

In these adopted California standards detailed in Table 1, a value about 15% lower than the CRC average emission was arbitrarily assumed.

The California exhaust standards

These standards represent an effort to set a performance standard for individual vehicles which, if attained will result in acceptable community air quality. The California Department of Public Health, which has set them up, hopes that necessary research will be done as soon as possible so that they may be validated, revised, or refuted in the shortest possible time.

Some uncertainties are inherent in their development. As with all standards, they do not eliminate the need for thought and judgment in their application.

The concentration of hydrocarbons and carbon monoxide expressed in the standards, for example, are qualified by requiring an adjustment to a dry exhaust volume containing 15% by volume of certain oxides. This qualification is intended to avoid giving credit for apparent reduction in contaminant

concentrations which can be achieved by the addition of dilution air.

The tabulation in the Standard labeled "Driving Cycle" describes a series of driving conditions which represent modes of operation in typical urban driving. The column headed "Per Cent of Total Time" derives from the Los Angeles Traffic Pattern Survey conducted by the Traffic Survey Panel of the Automobile Manufacturers Association. The column headed "Per Cent of Total Sample Volume" combines the time factor with an average exhaust flow rate for each condition. Thus, if a flow-proportional sample is taken, the schedule under "Per Cent of Total Time" should be followed. If concentrations are measured for each of the conditions, the schedule under "Per Cent of Total Sample Volume" may be used to develop a composite sample concentration.

This driving cycle creates some ambiguity in the evaluation of control devices, particularly catalytic devices. Since the efficiency of a catalytic device is temperature dependent, its efficiency at any given driving condition is dependent on the prior mode of operation. For example, the efficiency at a sustained 30-mph cruise condition may be markedly different from the efficiency for a short interval of 30-mph cruise sandwiched between an acceleration and deceleration. *The basic intent in the standards is that the composite sample should represent the actual urban driving experience,* and testing procedures will be adapted towards this end.

The driving cycle was developed for passenger vehicles and is not appropriate for truck and bus operation. Practical test procedures for these vehicles have not yet been developed.

The decision to express the standard as an allowable concentration in exhaust gases has implications which, in some respects, appear inequitable. A concentration standard essentially allows emission in proportion to fuel consumption. This gives no credit to the lower absolute emission from the small car operator, the person who uses only two gallons of gas per week rather than two per day, or the smog-minded citizen who belongs to a car pool for the trip to the office. An important argument for a concentration standard is its simplicity as compared to an allowable mass emission per unit time, distance or vehicle.

In judging whether a control device or system meets the standards, an allowance for warmup time must be made. If an appreciable time is required, emissions during the active period must be correspondingly lower.

Another consideration in device evaluation is the deterioration in performance with age. To be accepted as meeting the standards, it must be demonstrated that performance is sustained for the period of use for which the device is designed.

It seems likely that one of the conditions of approval will be a stated use period in units of miles or time. Furthermore, it must be demonstrated that the device performs satisfactorily on all of the makes and conditions of cars for which it is intended. If, for any reason, the Motor Vehicle Pollution Control Board chooses to exempt an appreciable number of vehicles it will be necessary to require more stringent controls on the remainder if the desired overall reduction in vehicle emissions is to be achieved.

To Order Paper No. 210A . . .
from which material for this article was drawn, see p. 6.

Air Cleaner Test Methods Undergo Probe

Based on paper by

E. H. Farnan

Tractor and Implement Division, Ford Motor Co.

and

J. A. Weber

University of Illinois

RESEARCH seeking to evaluate test factors that affect farm tractor, dry-type, air cleaner efficiency and to determine conditions which would simulate field operation, have brought to light numerous helpful facts. The findings and observations are as follows:

- Bench test efficiencies of a dry-type cleaner were lower with pulsating flow than with steady air flow, particularly with coarse dust.
- Feeding dust to a cleaner on a diesel engine and sampling from the intake air stream gave lower efficiencies than any combination of conditions imposed by the bench test.
- Determination of dry air cleaner efficiencies on a diesel engine by the sampling method gave values that correlated with field performance.
- The efficiency of an oil bath cleaner was higher on a diesel engine than on a steady flow bench test for either fine or coarse dust.
- On a dry air cleaner a slow feed rate of coarse dust gave a significantly lower efficiency than a fast rate.
- When an absolute filter was used in an engine intake system, it protected the cleaner on test and gave efficiency values that were higher than those obtained by the sampling method.
- It should be recognized that with a given air flow a water manometer reading of restriction will increase as pulsations are added to the air stream.
- Additional work would be desirable to obtain a better understanding of the effect of intake air pulsations on dry air cleaner operation and to apply the knowledge to the design of the intake system.
- Satisfactory field service has been obtained with two dry air cleaner designs. Cooperating farmers are enthusiastic about the application of satisfactory dry cleaners as standard equipment on farm tractors.

To Order Paper No. 216B . . .
from which material for this article was drawn, see p. 6.

Can methyl replace ethyl in

THIS article is based on the following papers and discussions:

Papers

Tetramethyl Lead — an Antiknock for Better Road Performance, R. H. PERRY, Jr., C. J. DIPERNA, and D. P. HEATH, Socony Mobil Oil Co., Inc. (Paper No. 207A)

Antiknock Behavior of Alkyl Lead Compounds, H. E. HESSELBERG and J. R. HOWARD, Ethyl Corp. (Paper No. 207B)

Utility of Tetramethyl Lead in Gasoline, D. L. PASTELL and W. E. MORRIS, E. I. du Pont de Nemours & Co. (Paper No. 207C)

Tetramethyl Lead Reduces Low-Speed Knock, T. M. KORN, Esso Research & Engineering Co., and **G. MOSS,** Esso Research, Ltd. (Paper No. 207D)

Discussions by:

F. W. KAVANAGH, California Research Corp.
H. R. JACKSON and L. J. TEST, Atlantic Refining Co.
R. O. GIBSON, Associated Ethyl Co., Ltd., and Errol J. Gay, consultant
G. P. ANDERSON and D. S. ELLIS, British Petroleum Co., Ltd.
H. F. HOSTETLER, R. H. KLEIN and W. T. WOTRING, Standard Oil Co. (Ohio)
Secretary's report of oral discussion, **L. ELTINGE,** Standard Oil Co. (Ind.)

Order copies of papers ONLY (not the discussions), by number, on p. 6.

CHANGES in refinery processing over the past few years are mainly responsible for the present interest in tetramethyl lead as a substitute for tetraethyl lead in gasoline. These changes are resulting in the production of gasolines of ever higher octane number, with increasing percentages of catalytic reformate in the fuel. In cars equipped with manual transmissions, particularly if the induction system allows an appreciable degree of fuel segregation (separation of light and heavy components) at low engine speeds, the tetramethyl lead seems to be more effective than tetraethyl lead in suppressing knock in multicylinder engines.

Table 1 presents an estimate of the road octane-number advantage, in manual transmission cars, that would be incurred from the substitution of tml for tel in catalytic reformate gasolines. In 50% of the free world's production of manual transmission cars, an increase of 3 road O.N.'s or greater would be achieved. In 90% of the free world's production, there would be an increase of about 2 road O.N.'s.

Of course, less advantage would be observed in cars with automatic transmissions or in fuels that did not contain catalytic reformate as the major component. In U. S. automatic transmission cars, an additional 2 road O.N.'s are frequently obtained with tml in reformate gasolines. More typically, the improvement would be around 1–1¼ road O.N.

In catalytically cracked gasolines, substitution of tml for tel would seldom effect a road octane-number gain in automatic transmission cars; indeed, in many instances, it would cause a slight loss (less than 1 road O.N.). However, even with these gasolines, a slight road octane-number gain (generally less than 1 unit) may be observed with manual transmission cars.

Properties of tml

The properties of tml that, under certain conditions, make it more attractive than tel as an antiknock agent are:

- Higher intrinsic antiknock value with highly aromatic fuels.
- Lower boiling point.
- Higher vapor pressure.

tetraethyl lead?

As the per cent of aromatics increases in catalytic reformate gasolines, the added benefit from substituting tml for tel increases. Just why this happens is not really known.

Tml is the most volatile of the lead alkyls — it boils at 230 F, compared with about 390 F for tel, and has 100 times the vapor pressure of tel at 65 F.

This greater volatility of tml means that it will be more evenly distributed throughout the boiling range of the fuel under conditions where fuel segregation is combined with a fuel having low antiknock components of high lead susceptibility in the more volatile portion.

Fuel segregation frequently occurs in induction systems under low-speed wide-open-throttle accelerations, such as can occur with cars having manual transmissions (wot accelerations in high gear are not possible in cars having automatic transmissions). This separation of light and heavy fuel components is due to the very low velocity and low turbulence of the mixture at such low engine speeds. The sudden introduction of additional fuel to the low turbulence air stream is likely to mean that, for a short period of time, the liquid fraction will not be distributed uniformly to all cylinders.

With catalytic reformate fuels, the lighter fractions consist largely of low-octane components, that are very susceptible to octane improvement by the addition of lead. Thus, when these low-octane components, which will also be short of lead if the higher boiling tel is used, reach the cylinder, knock is likely to occur. This knock will continue until the liquid film of heavier components on the manifold wall reach the cylinders in an amount and at a rate sufficient to provide adequate portions of all components. (The more volatile tml will, however, be largely volatilized along with the light components, which thus retain the octane benefit of the lead compound.) This transient low-speed knocking is not likely to occur with catalytically cracked gasolines because the octane numbers of the volatile fractions are at least as high as those of the heaviest fractions, and the light fractions also have low lead susceptibilities, and thus the absence of tel is not particularly harmful.

Table 1 — Road Octane-Number Improvement from Substitution of Tml for Tel in Reformate Gasoline

(at lead concentrations of over 2 g per gal)

% of Car Population	Road Octane No. Improvement from Tml				
	Italian Cars	French Cars	English Cars	German Cars	American Cars[a]
90	3	2	2	1	3
75	4	3	2½	2	4
50	6	3½	3	3½	4½
25	6	5	4	5	5

[a] Manual transmission cars only.

Where tml works best

The relationships between tml antiknock effectiveness and fuel composition are complex. It does, however, appear that a few generalizations can be made on the relative effectiveness of tml to tel. Thus, it appears that the antiknock effectiveness of tml relative to tel at equal metallic lead concentrations increases with:

- Increasing aromatic content.
- Increasing leaded octane number.
- Increasing lead content.
- Decreasing sulfur content.
- Decreasing tel susceptibility.

Thus we see why a catalytic reformate gasoline, which contains a high percentage of aromatics, which have a high natural octane number and high tel susceptibility, will benefit most from the substitution of tml for tel, especially if the lead content of the gasoline is high. When the sulfur content of such fuel is low, the benefit is even greater.

Possible problems with tml

Possible problems with tml include its toxicity and its effect on:

- Combustion-chamber deposits.
- Surface ignition.
- Spark-plug performance.
- Gasoline stability.

Tests with rats indicate that tml is actually less toxic than tel, in that a higher contentration of tml is required to reach a lethal dosage. In general, it appears that tml and antiknock compounds containing tml should be handled and used with the same precautions as with tel and tel mixes.

As for the other possible problems mentioned above it does not appear that any of them are real cause for concern. There are no significant differences in the combustion-chamber harm characteristics or spark-plug fouling characteristics between tml and tel compounds. Similarly, tml appears to have no adverse effect on gasoline stability.

The only possible cause for slight concern is that, under some conditions, tests now in progress indicate that tml may slightly increase the surface-ignition tendency of an engine.

design limits for

unstable aircraft

Flight tests show pilots can handle highly unstable aircraft. Adherence to minimum stability limits promises safe landings if artificial stability augmentation system fails.

Based on paper by

Gifford Bull

Cornell Aeronautical Laboratory, Inc.

THE MINIMUM natural longitudinal stability of aircraft can now be safely set by the designer as a result of continuing studies by the Cornell Aeronautical Laboratory. Extensive flight tests in a variable stability airplane have defined the point at which the flight motions of the airplane can no longer be handled by the pilot. The results of the work to date are shown in the two graphs. The data are for the most exacting maneuver a pilot might make in returning after his artificial stability augmentation system has failed . . . making a mirror landing on an aircraft carrier.

The unique form of the stability parameters plotted in the graphs results from the problem of trying to report pilot ability in both the stable and unstable range of an airplane, and still have a continuous method of describing the motion of the airplane. This is further complicated by the fact that there are two modes of oscillation in the longitudinal direction, a short period one that involves pitch and angle of attack, and a long period (phugoid) one in which the pitch and speed vary. Normally, the two modes are widely separated in their frequencies, but as aircraft stability becomes negative, their effects overlap.

This problem was solved by duplicating the motions of the airplane in an analog computer and relating pilot opinion to the roots of the equations of motion. The equation which describes the aspects of the motions that seem to be important to the pilot can be expressed as:

$$x^2 + (\lambda_1 + \lambda_2)\, x + \lambda_1 \lambda_2 = 0$$

where x represents any of the variables in the longitudinal motion, such as angle of attack or pitch angle.

When the motion of the airplane is oscillatory, the equation is generally written as:

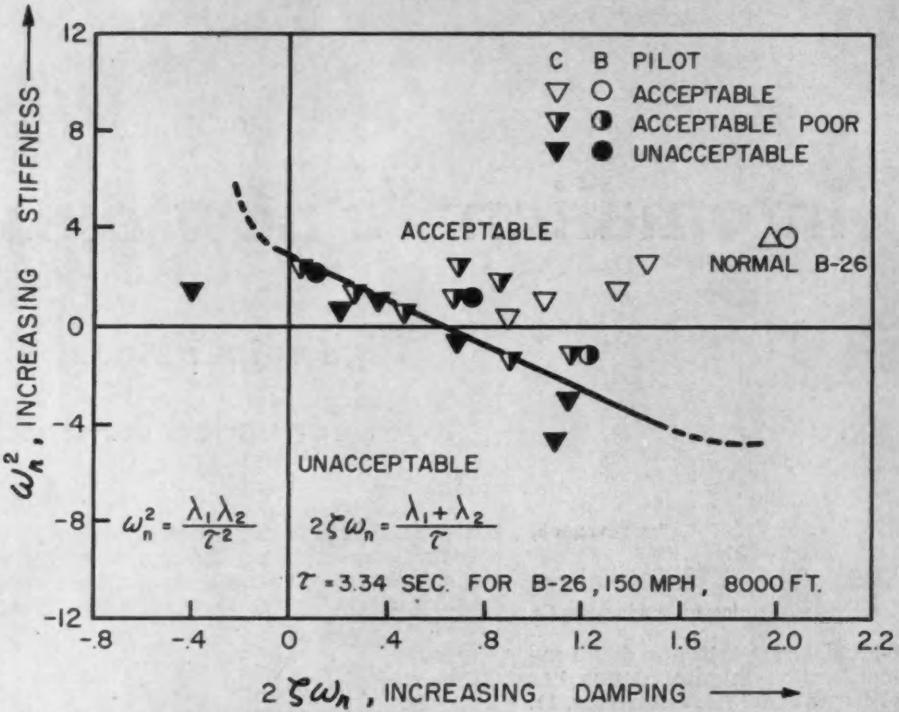
$$x^2 + 2\zeta\omega_n x + \omega_n{}^2 = 0$$

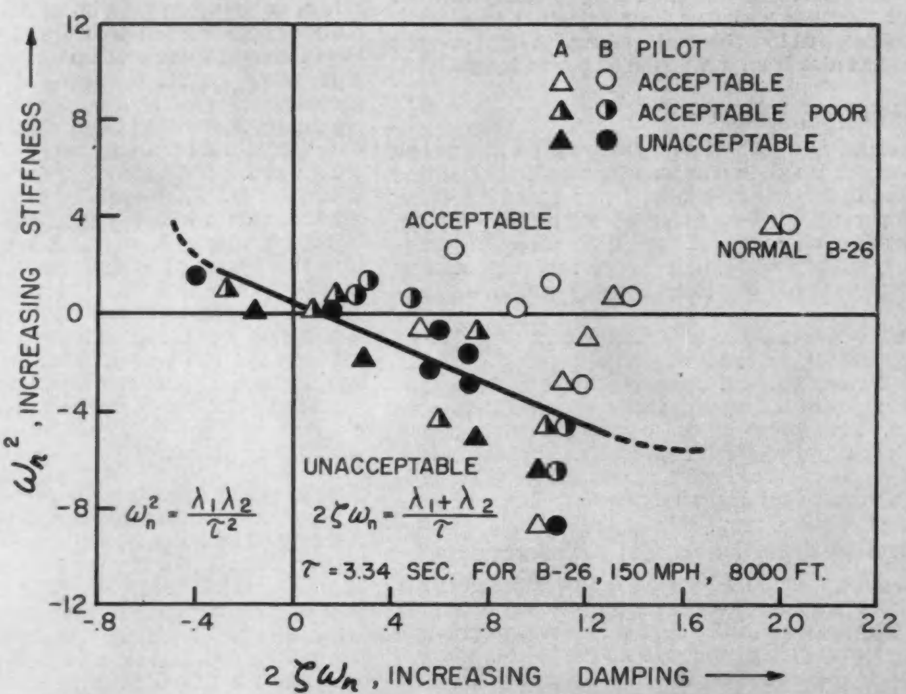
where ω_n is the undamped natural frequency of the motion and ζ is the damping factor. Thus, the sum of the roots, $\lambda_1 + \lambda_2$, expresses the damping of the motion, while the product of the roots, $\lambda_1 \lambda_2$, expresses the frequency of the motion, or the stiffness of the "spring" restoring the airplane to equilibrium.

The same form of the equation can be used for the unstable case. Then, the negative value of the product, $\lambda_1 \lambda_2$, represents a negative spring or divergence, and a negative value of the sum, $\lambda_1 + \lambda_2$, represents negative damping. Negative damping for a positive spring means an oscillation which grows in amplitude, while negative values of damping with a negative spring simply means a faster divergence.

To order Paper No. 171B . . .
from which material for this article was drawn, see p. 6.

Boundary of minimum flyable handling qualities—longitudinal motion





International's new diesel

High output Model 817 is for varied construction

Based on paper by

D. J. Bundy and E. H. Stromberg

International Harvester Co.

A 6-cyl, 4-stroke-cycle, direct-injection diesel engine of open-combustion-chamber design has been developed by International Harvester (Fig. 1). With a bore and stroke of $5\frac{3}{8} \times 6$ and displacement of 817 cu in., it features good fuel economy at high output together with low heat rejection to coolant and subsequent low thermal loading. A light-weight model has also been developed to power trucks.

Fuel-injection system

An external injection pump meters the fuel at low pressure for maximum accuracy and distributes this metered fuel to the mechanically operated injectors, which provide high-pressure injection into the open combustion chamber. These high injection pressures combined with swirl insure thorough mixing for maximum combustion efficiency and air utilization.

The injector is a low-cost, simple unit (Fig. 2) and the tip is designed to match the contour of each engine. Seven 0.007-in. diameter holes with an included angle of 160 deg are used on the turbocharged engine. Five 0.0083-in. holes with 130 deg included angle are supplied on the naturally aspirated model. An offset counterbore on the intake valve ports provides a swirl to aid in the mixing of fuel and air.

Minimizing distortion in wet cylinder sleeve

The design of the wet sleeve cylinder provides direct heat transfer to the coolant to maintain an even temperature in the cylinder sleeve, thus minimizing sleeve distortion and increasing life. Distortion is also guarded against by providing a direct path between the cylinder head studs and the main bearing cap bolts. The main bearing capscrew bosses are tied in with the lower deck of the crankcase to eliminate the possibility of stress concentration. These forces are then transmitted through the cylinder sleeve barrel to the cylinder head stud bosses.

Cooling of pistons

The pistons are aluminum castings with a ni-resist top ring carrier. A fixed jet sprays the underside of each piston with oil at the rate of 1.5 gpm to reduce operating temperatures (Fig. 3). Because of the increased valve overlap on the turbocharged engine, valve pockets are required on its pistons. On the naturally aspirated engine with reduced overlap, maximum squish has been used in the combustion chamber to aid in mixing fuel and air.

Two cylinder heads of three cylinders each are used (Fig. 4). Each cylinder has two intake and two exhaust valves with the mechanically operated fuel injector centrally located. A copper sleeve is rolled into the center of each cylinder for mounting the injector. The two valves are operated simultaneously through a valve bridge. One side of the bridge is adjustable to compensate for variations in height between the two valves. Positive rotators are used on all valves. Exhaust valves are Stellite-faced and seats have chrome-tungsten alloy inserts.

Weight reduction

Such parts as valve covers and housings, filter headers, oil pan, and intake manifold are aluminum, thus reducing weight without sacrifice of durability. The engine oil pan is reversible to facilitate varied applications of the engine. The truck model engine also uses aluminum for such parts as water manifolds, flywheel housing, front cover, oil and water pump housings, and oil cooler.

The fan is gear-driven to eliminate the maintenance problem so common with belt drives on construction equipment. To dampen out the torsional

engine

designed

equipment

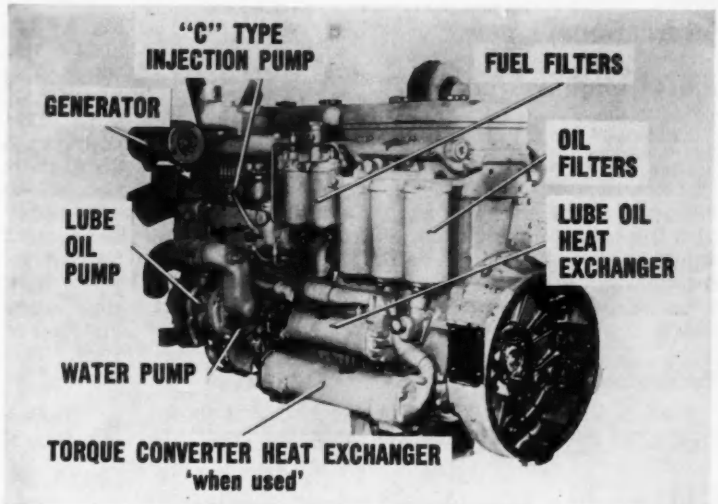


Fig. 1 — Left side of the International 817 diesel engine showing externally mounted oil and water pumps. A scavenging oil pump can be included to provide high-angle operation.

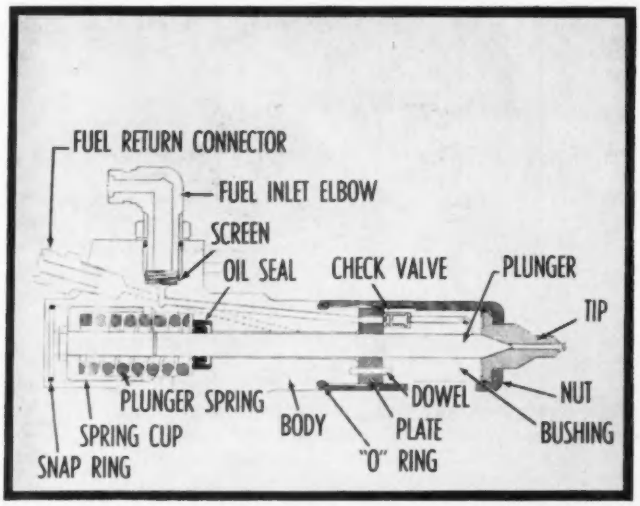


Fig. 2 — High injection pressure is provided by a simple, low-cost injector. High pressure combined with air swirl gives maximum combustion efficiency.

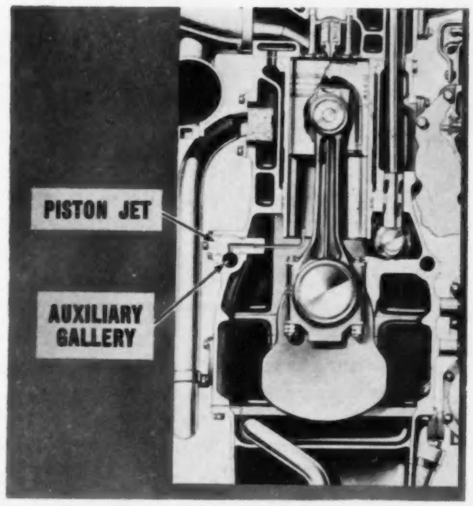


Fig. 3 — Aluminum pistons are oil-cooled by fixed jet to reduce operating temperatures, wear, and deposit formation.

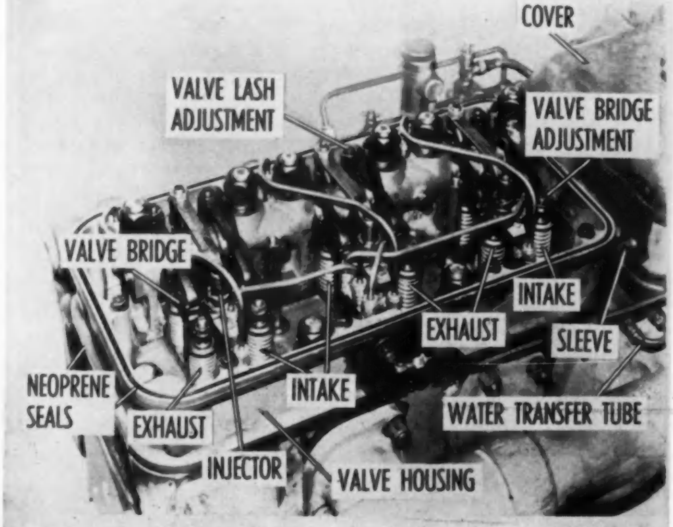


Fig. 4 — The in-line engine has two cylinder heads made from copper-nickel-chrome gray iron castings. Each head serves three cylinders.

International's new diesel engine

. . . continued

vibration of the engine, a rubber section is designed into the fan mounting then, to prevent overworking the rubber, a slip clutch is provided, limiting the torque to an allowable value. The truck model has a belt-driven fan which eliminates the weight of gears.

Performance

Performance of the turbocharged engine is shown in Fig. 5; that of the naturally aspirated engine in Fig. 6. The turbocharged engine is rated at 375 bhp at 2100 rpm, or 173 bmep. With a weight of 3540 lb, the lb/hp-ratio is 9.4. The brake specific fuel consumption, calculated on observed horsepower, is 0.395. The naturally aspirated engine has a 250-bhp rating at 2100 rpm and, with a weight of 3500 lb, the lb/hp-ratio is 14. The brake specific fuel consumption is 0.430.

At rated speed and load the turbocharged engine has a specific heat rejection of 25 Btu per min per bhp, while that of the naturally aspirated engine is 30.5. On this basis the increase in total heat rejection to the coolant is 32% greater with the turbocharged engine than with the naturally aspirated type. This would represent the increase in thermal loading for a 58% increase in output.

To Order Paper No. 198A . . .
from which material for this article was drawn, see p. 6.

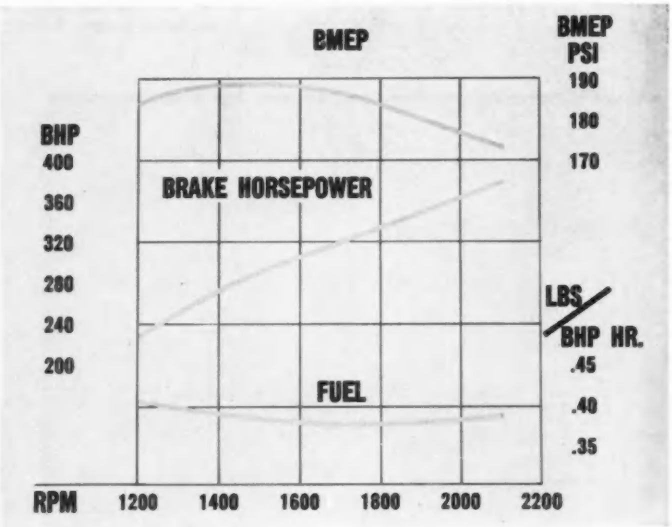


Fig. 5 — Performance data over entire speed range of model 817 International turbocharged diesel engine.

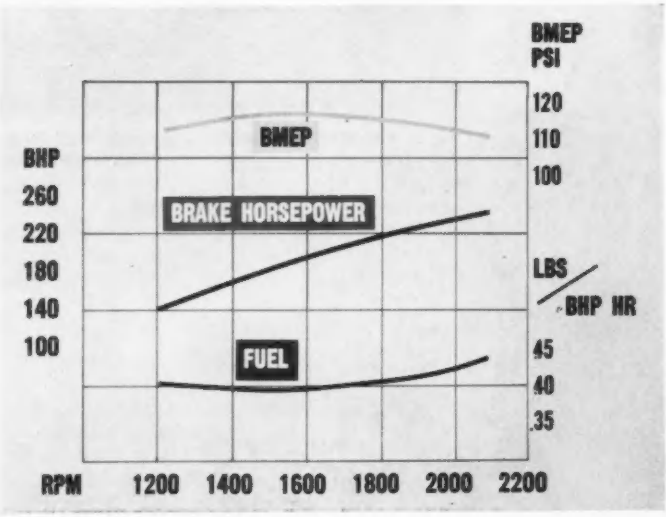


Fig. 6 — Performance data for naturally aspirated International diesel engine developed for construction equipment such as payhaulers, scrappers, crushers, generators, and hammermills.

That "last 5 hp"—

Does it benefit the car owner as much as other advantages the engineer could trade for it?

Based on paper by

M. F. Sterner

Holley Carburetor Co.

WHAT IS THERE about that last 5 hp that makes it so "essential" in an engine design . . . and that causes so much upheavel in the getting of it?

No matter what the horsepower of any given engine, the engineer seems always to be told that it is of the utmost urgency that it be upped a little. If yesterday's 300-hp engine is to be derated to 200 hp, then 205 hp is acceptable. But not 195 hp . . . even though extreme measures may be called for to recover the "lost" 5 hp. . . . Or, if a smaller engine is designed for the 200-hp requirement, it may be necessary to resort to the esoteric to get the last 5 hp to achieve the designated goal.

"If they would just leave that last hp in the engine, both the engine and the engineers would be better off," a harried development engineer said recently at the end of one of these 5-more-horse-power-or-bust upheavels.

THIS ARTICLE details the effect upon overall performance and user viewpoint of that "last 5 hp."

TO GET JUST 5 HP MORE from a given engine may sometimes cheat the owner of economy and overall performance benefits while giving him negligible power advantages. Only 1 hp of that "last 5 hp" in a 200-hp engine is likely to be available for use in customer's major-use driving ranges.

To see how this "last 5 hp" of the gross 200 hp gets down to 1 hp, study of the typical engine power curves in Fig. 1 provides a good start. The engine involved produces 200 hp (gross). Yet only 125 hp (five-eighths of the gross) actually becomes available to propel the wheels. The other three-eighths of the gross has already been used up. So, the original "last 5 hp" has already become only $3\frac{1}{8}$ by the time it gets to the wheels.

Further reduction to $2\frac{1}{3}$ hp is shown from examination of that portion of the curve that covers the horsepower equivalent of average day and night speed limits. What this actually does to maximum vehicle performance is revealed by Fig. 2. This shows a road-load horsepower requirement curve for a typical vehicle that might use this 200-hp engine. It shows that a net loss of only 1 mph in top speed would accrue from 195 original hp in the engine as compared with the designated 200 hp. With even a 10-hp loss (an original 190-hp engine) less than 2 mph would be lost in top speed.

This means that, in the maximum acceleration range, the loss has been diminished to $2\frac{1}{3}$ hp. Acceleration in direct drive would drop approximately 3% . . . and through gears even less. It might take as long as 10.2 sec instead of 10 sec, in other words, to accelerate from 0 to 60 mph!

Fig. 3, another step in analysis of what happens

That "last 5 hp"–

. . . continued

when the much-pressured "last 5 hp" is lost, shows that the average driver spends most of his time accelerating and decelerating; that he spends as much time at idle as in steady cruising. It shows also that almost one-half of total driving time is a condition in which no power at all is required.

And from Fig. 4 we find that — in the most-used driving speed ranges — the driver gets almost as good performance from the car powered with the 195 hp engine as from the one with the 200 hp unit. Also, it shows that the driver uses only 3½% of the gross horsepower rating to drive steadily — and 20% to accelerate at a maximum rate. (It is apparent that the most important speed range is the "grocery-store-driving" area — from 10 to 35 mph.)

The original 5-more-hp thus is shown to have dwindled to about 1 hp in the customer's major-usage range.

It is clear, then, that loss of 5 hp at the peak engine speed has little ultimate significance to the car owner.

Something better is available

So, a design engineer may properly ask himself: "Can't I trade that 5 hp for other elements of design that *will* bring measurable benefits to the owner?" His answer is almost certain to be: "Yes, there usually is something better we can give the owner if we give up that 'last 5 hp.' There are, in fact, quite a few "something betters."

Important among the "something betters" are likely to be improved economy, performance, and driving characteristics made available by heating the inlet air to higher temperatures. (A 30 F increase in inlet air temperature in this hypothetical 200-hp engine will "lose" about 5 hp.)

Economy improvement, for example, results from sufficient heating of the inlet air to provide optimum vaporization of the combustible fuel-air mixture . . . which determines how much built-in "choke" or enrichment must be left in the basic carburetor calibration to give satisfactory driving characteristics.

The higher inlet air temperatures can also result in:

- Better performance through the resulting improved distribution of the fuel-air mixture.
- Gains in economy and driving characteristics, because — with the improved vaporization — less enrichment and shorter choke duration will be required for satisfactory performance.
- Elimination of ice formation in the entire induction system from carburetor to manifold.

Studies of the ice-elimination problem indicate that an inlet temperature of 70–75 F will prevent the major portion of all icing in the induction system. It was also indicated that 90 F is necessary to insure elimination of icing under all conditions.

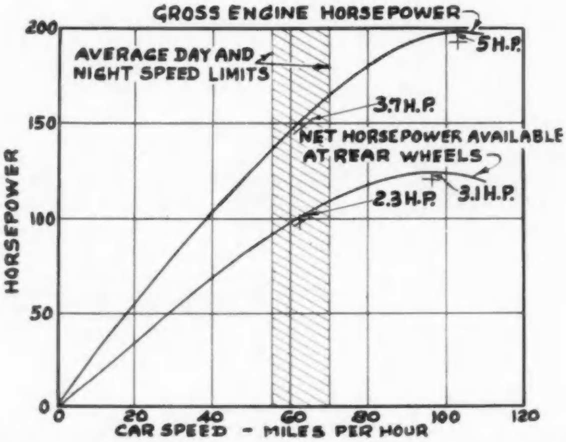


Fig. 1 — Power curves for a typical 200-hp engine. Only five-eighths of the original horsepower gets to the wheels.

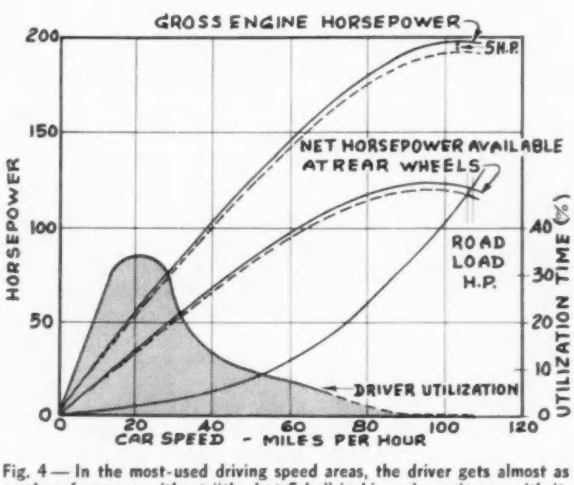


Fig. 4 — In the most-used driving speed areas, the driver gets almost as good performance without "the last 5 hp" in his car's engine as with it.

(Fig. 5 shows a close correlation with these findings.)

Economy may be achieved also by restriction of the induction system at proper points. A smaller carburetor, for example, may be possible if the "last 5 hp" is sacrificed . . . which would permit increases in metering forces by as much as 45% . . . which, in turn, would bring gains in terms of more stable metering . . . which would permit operating on leaner mixtures and with diminished accelerating pump capacity . . . which would improve economy.

If the "last 5 hp" is worth additional cost, the higher temperatures for the inlet air can be achieved without sacrifice of the whole 5 hp by adding thermostats. These can be used to regulate the temperature to a minimum at top speed, where the least heat is required.

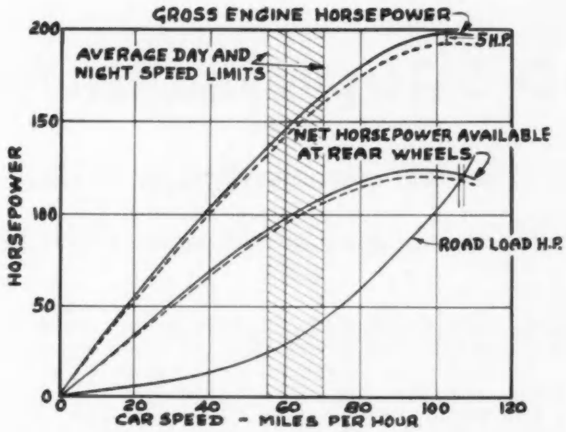


Fig. 2 — Road-load horsepower requirement for typical vehicle powered by a 200-hp engine. Less than 1 mph top speed is lost through loss of 5 hp from the original 200 hp gross.

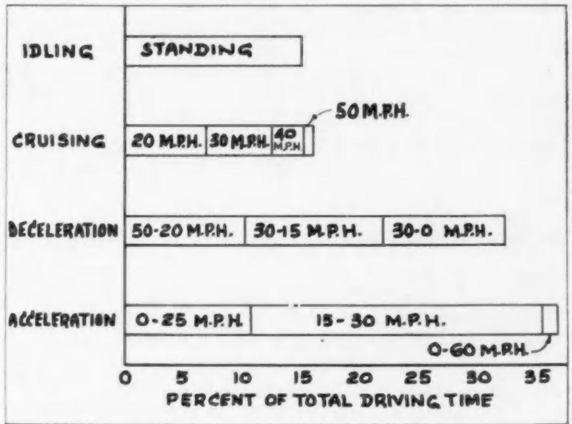


Fig. 3 — The average driver spends most of his time accelerating and decelerating; as much time idling as cruising. (From survey of "Los Angeles County Traffic Pattern" by Automobile Manufacturers Association, 1957. . . . See article in SAE Journal, November 1957, pp. 72–73.)

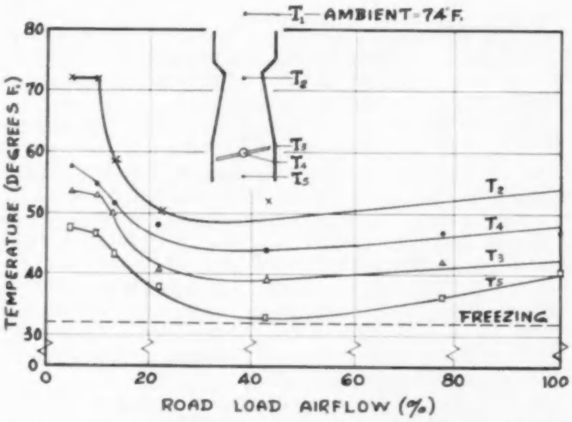


Fig. 5 — Test results indicate that an inlet temperature of 70–75 F will prevent a major portion of all icing in the induction system; also that 90 F is necessary to insure elimination of icing under *all* conditions.

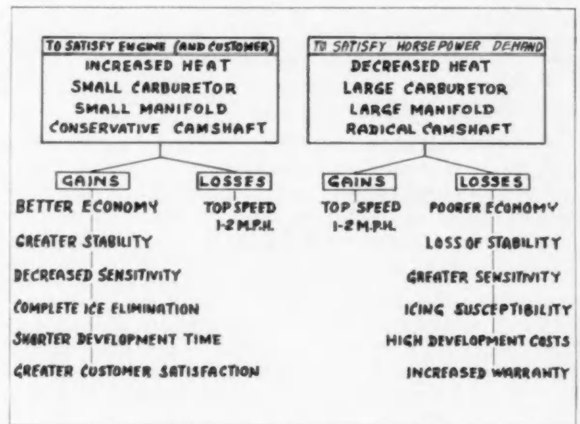


Fig. 6 — Summary of gains and losses involved from decision to get or forego that "last 5 hp."

Costs of the "last five"

Frequently, to wrest this last 5 hp from an engine design, the engineer is forced to increase development time by an excessive amount. It is commonly noted that the first 90% of the power is achieved in 10% of the time; the last 10% in 90% of the time.

Besides, the engineer will have to come up with a carburetor and manifold combination that is marginal in driving feel and susceptible to misbehavior as soon as any sign of deterioration appears in the overall combination.

Fig. 6 summarizes the gains and losses involved in the decision to get or forego that "last 5 hp."

To Order Paper No. 199A . . .
from which material for this article was drawn, see p. 6.

AUTHOR STERNER has been helping to combine power and economy in engines ever since he graduated from the University of Michigan 21 years ago.

He has faced the problem of trying for power and economy at the same time in both aircraft and ground vehicle powerplants . . . always as a member of the Holley Carburetor engineering staff. He has been chief engineer of Holley's Automotive Division since 1952.

Job shops can justify

Small shops can rent computer time by the hour

Potential dollar savings may permit larger shops to

Based on report by panel secretary

L. B. Musser

Bendix Aviation Corp.

THE COST OF ITEMS produced in a job shop — because of the small quantities involved and because of the high cost of tooling for limited runs — is relatively high compared to larger production runs. Also, operation efficiency is limited by the constant need for retooling, changing setups, ordering stock, scheduling machines, and meeting delivery schedules. The solution to these problems involves the control of operations by computers.

Three areas to consider when applying automation practices to the job shop are:

1. **Administrative control.**
2. **Parts planning and machining.**
3. **Production control.**

Administrative controls

Control of a job shop begins with administrative controls. The entire facility should be organized under a systems concept. A flow chart should define the relationships of personnel and operations. Administration and manufacture will be by projects. Individual efforts from sales to purchasing to manufacturing and, finally to shipping will be interrelated, and the management of projects and machines will supplant the management of men.

To achieve administrative control requires using computers for the functions of procurement, materials handling, data processing, production control, and inspection. Once an order is processed by the sales department, all subsequent functions become virtually automatic as determined by computers. This is a logical step since the requirements of process engineers and planning personnel are limited. The computers will permit study of the entire problem. They will tie manufacturing and administration together.

The heart of this control lies in the methods used for production. Numerical control, the control of machines through numbers recorded and coded on a suitable storage medium such as punched tape, permits more efficient operation and utilization of machine tools in the plant. This, in turn, reduces the number of instructions to the operator and eliminates costly operator errors. Furthermore, coordination between engineering and manufacturing is enhanced since many of the engineers' instructions are translated immediately to tape with no intermediate steps where attempts might be made to reinterpret or to analyze the engineers' desires. Where it becomes necessary to develop prototypes before beginning production, reliability of the production pieces can be assured by checking against the tapes which machined the prototypes and which were proven through test.

Machining

Numerical control makes flexible automation a reality in many job shops. It permits the job shop manager to produce his parts at higher rates and lower cost than previously possible.

The two basic types of numerical control are contouring and positioning. The first is used principally in milling, turning, and grinding operations, while the second is used for point-to-point positioning where the path between points is not controlled.

Contouring control has been applied quite successfully on small knee mills, and on general purpose milling, drilling, and boring machines. Applications also have been made to lathes and other types of turning machines. Large skin mills and profilers have been equipped successfully with continuous contouring control.

Numerical positioning control is a much broader field. It is a type of control which finds ideal application on drilling machines, jig borers, and such. In one application where positioning control was applied to a six spindle, turret-type drilling machine, 124 different drill jigs with an average cost of $1500 each were eliminated by numerical control positioning. The use of the numerically controlled machines eliminated the need for special tooling costing six times the machine and control investment. Numerical positioning control has been applied to many special purpose drilling machines for various types of industrial applications and to layout drilling machines for working dies, jigs, fixtures, molds, and other tools of high accuracy.

The primary savings provided by numerical control are in tooling and lead time, machine utilization and worker productivity, and in consistent, high-quality production. It is this performance which is of value to the job shop. A manager can be assured of accuracy in part after part. Better parts mean less inspection. Thus, through the use of numerical control for machine tools we can expect consistently better parts produced faster and at lower cost.

computer use

to control operations.

have a computer of their own.

Parts processing and planning

Both point-to-point positioning and continuous path control operate the machine tool through the use of tape. Tape processing, therefore is of major importance to a job shop operation. The processing of the tape can make the difference between economic success or failure of the entire venture when using numerical equipment.

The preparation of tape for point-to-point positioning systems is simple, direct, and as fast as the operation of an adding machine. Through the use of tape, the requirement for expensive jigs and fixtures is eliminated. It is no longer necessary to make layout calculations in the factory.

Preparation of tapes for continuous path numerical control, however, presents a problem. A more searching analysis is required to justify the substitution of tapes for the models and templates. To assist in this analysis, consider the information cycle. First, the part drawing is converted by men and computers into numerical tape. The process planner's task is largely dependent upon the computer and the amount of decisions automatically handled by it. The more the computer and its routine can assist the process planner, the easier it is for him to make a tape.

Some considerations in the selection of computers are that a small computer with a weak routine will require a relatively high man-effort to produce a tape. However, a large computer with powerful routines will require a minimum of data describing the part. In this latter case the effort of the part processor is held to a minimum and the computer makes most of the decisions necessary to machine the part.

In selecting the computer, the speed at which it will do the work must also be considered. The larger computers are many times faster than the small, relatively inexpensive computers. The overall utilization of a computer must be considered if computer requirements are to be determined. Will the computer be used for data processing, numerical control tapes, engineering, and production control? If not, will there be sufficient loading of the computer to justify its installation in the job shop?

If, after reviewing the above points, the manager of the job shop determines that he cannot justify a computer, what then are his options? Tapes can be made in computing centers where the time on a computer is leased, or they can be prepared at various locations throughout the country where tape preparation is performed on a contract basis. On a contract basis, the tool engineer furnishes to the tape preparation agency information regarding metal removal, feeds, speeds, and tooling. The entire processing can then be performed by the agency.

In the future, job shops which own numerically controlled machining equipment may receive tapes from prime contractors. The job shop, in turn, will sell time on its numerical equipment. Thus it will be a simple matter to manufacture parts precisely to the contractor's specifications.

Production control

An example of the final step in the automation of the job shops — production control through the use of computers — has been accomplished by IBM. One plant produces approximately 80 different products, involving a total of 45,000 different parts. Production scheduling of 18,000 of the parts is accomplished by computer. Production is planned 12–24 months in advance.

An IBM-705 is used to generate orders for manufacturing in economical quantities. Because of the varying rates of incoming orders this involves continual changes in the production schedule. Twice a month a report is provided indicating the quantity of parts in stock versus the open order position.

A second report, the machine load report, is prepared on a weekly basis. This report indicates to management the work on the floor, and relates this work to peak load areas in the plant and open areas. The report indicates this information 40 days in advance of production, thus permitting management to schedule for more economical use of the equipment. It indicates to management when it may be necessary to add personnel to perform the work, accomplish the work on an overtime basis because of the quantities involved, or to subcontract the work to outside vendors.

The computers, and the reports obtained through their use enable more efficient scheduling of production, manpower control, and forecasting. By comparing the actual performance with the predicted performance, an overall index of plant performance may be obtained.

Smaller computers can solve production and inventory control problems, although not as efficiently. A job shop, whether large or small, should introduce computers to their operations gradually. They should start by renting computer service. After gaining some experience, they may be able to justify a computer of their own. While the computers are important, they are no better than the personnel used in programming and operating them. It cannot be overstressed that well-trained personnel should be used in this type of work. They are the key to successful operation, through all phases of automation of the job shop.

Serving on the panel Automation in the Job Shop upon which this article is based, in addition to the panel secretary, were: chairman **R. M. Nelson**, The Bendix Corp., **J. G. Moore**, The Bendix Corp.; **M. Levine**, Pratt & Whitney Division of United Aircraft Corp.; **J. A. Baker**, General Electric Co.; and **J. Clark**, IBM Corp.

(This article is based on a report of one of 11 panels on production subjects. All 11 are available as a package as SP-330. See order blank on p. 6.

Operational and Fatigue Affect Roller Clutch

Based on paper by

R. E. Sauzedde

New Departure Division of GMC

MANY VARIABLES of operation and fatigue affect the design of production roller clutches. This article suggests certain parameters to consider in the design of these clutches and proposes a method for calculating the loads and stresses with which the designer must contend.

General design parameters

Industry-wide experience with production roller clutch designs indicate that, for most general applications, the following parameters can be recommended:

1. Included angle of 5–8 deg — constant or slightly decreasing.
2. Hertz stress at inner contact:
   $S_{(max)} \leq 700,000$ psi
   $S_{(mean)} \leq 550,000$ psi

where:

$$S_{(max)} = 1.27 \times S_{(mean)}$$

3. Hoop stress in outer race $\leq 80,000$ psi
4. Rollers:
   - Material — SAE 51100 or 52100 through-hardened
   - Hardness — Rockwell C 62 minimum
   - Diameter — 0.250–0.375 in. held to $\pm$ 0.0002 in.
   - Surface finish — 10 rms maximum
   - Length to diameter ratio — over 1–1; under 3 – 1
   - Note: end effects can be minimized by generous radii and/or tapering each end for 1/4 of the 0.0001 in. length
5. Cam Race:
   - Material — 20–60 carbon steels (such as SAE 8620 or 5160)
   - Hardness — Rockwell C 28–48 core; surface hardness 60 minimum, 0.060 in. minimum depth
   - Surface finish — 80 rms maximum
   - Taper — within 0.0005 in. for the length of the roller
6. Plain race — same as cam race except: Surface finish — 20 rms maximum
7. Energizing force — 4–16 oz per roller depending upon application
8. Concentricity control — within $\pm$ 0.007 in.
9. Lubrication — required for decreasing overrun friction but not for cooling.

Functional life checks should include:

1. 200,000 cycles at design load (based on 100,000 miles transmission life with two wide-open-throttle starts per mile)
2. 50 shock load cycles at twice design load applied in 0.02 sec.

Suggested methods of calculation

Although there are many ways of calculating the loads and stresses, the following method is given as typical:

Step 1: Assume race and roller diameters, included angle, roller length, and torque capacity required.

Step 2: Calculate from the geometrical relationship the load per roller normal to the inner surface

Step 3: Calculate the mean Hertz stress from either Roark or New Departure equations.

Step 4: Calculate the hoop stress in the outer race from Timoshenko's equation:

$$\sigma_{t\ max} = P\left(\frac{a^2 + b^2}{b^2 - a^2}\right)$$

where:

σ_t = Tensile stress in outer race

Factors

Design

P = Internal pressure
a = Radius of circle defined by cam reentrant corners
b = Outer radius of outer race

Step 5: Revise assumptions to suit acceptable parameters.

Note that either the load per roller or its equivalent in terms of torque can be used in the stress equation. Also, if a finite mean Hertz stress of 5.5×10^5 is decided upon, the maximum torque that the clutch should handle can be obtained directly from the following equation:

$$T_{max} = 8300\ nt \left[\frac{rR^2}{r + R}\right] \sin \alpha, \text{ lb-ft}$$

where:

T = Torque
n = Number of rollers
t = Length of roller
r = Radius of roller
R = Outer radius of inner race
α = Angle of attack

Conclusion

Dynamic clutch problems are the ones most likely to lead to malfunctions and are the most difficult to predict. Since clutch calculations are usually based on static conditions, the general design guides given in this article must be tempered by actual test experience. Shock loads may occur in one design necessitating a more conservative approach while in another the suggested parameters can be materially exceeded with excellent results in production. For example, one well known production roller clutch is designed to a maximum Hertz stress approaching 900,000 psi. Also, honed or ground cams may be necessary for better surface finish or for dimensional control. As is done with most other highly stressed mechanisms, make an intelligent guess and then try it out.

To Order Paper No. 208B . . .
from which material for this article was drawn, see p. 6.

ROLLER CLUTCHES of the one-way type are used in passenger-car transmissions to:

1. Automatically change torque converters into fluid couplings.

2. As free wheelers in constant-mesh, countershaft-type spur gear transmissions

3. As a means of easing the shift-timing problems in automatic transmissions of the planetary-type.

These applications have much in common yet may impose different requirements on a one-way clutch. For example, the problems in a converter application may entail wear consideration, centrifugal effect, and almost instantaneous race reversals. The use of an internal cam roller clutch allows the centrifugal force on the rollers during free wheeling to practically eliminate wear yet assures positive engagement on fast reversal due to the inertia effect of the rollers.

As free wheelers, the problem may be associated with shock loading at synchronization of rotating races and their associated shafts, gears, and such.

In planetary-type automatic transmissions, many different conditions may exist depending on the type of gearing used, the type of controls (hydraulic, electric, or mechanical), and the variety of shift sequences.

With the low-gear reaction clutch in the Hydramatic, the imposed load on the clutch can be held to a maximum until the upshift takes place whereas, in a converter application, the imposed load can be maximum only at full stall. Thus each design should be carefully analyzed as to the operational requirements on the clutch such as shock loading, deflections under load, eccentricities due to manufacturing tolerances effecting usable cam rise, centrifugal effect on rollers, energizing (or tickle) force, and such. Also, the matter of fatigue life should be considered both from the compressive and hoop stresses imposed.

This article gives general design parameters and suggests methods of calculating loads and stresses for production roller clutches.

At Buick

computers simulate

acceleration and fuel economy of passenger cars

Based on paper by

R. K. Louden,
IBM*

and

Ivan Lukey,
GMC

SIMULATION of automotive fuel economy and full throttle acceleration upon digital computers is a new and powerful tool available to the automotive engineer. Simulation studies provide information on the effects of proposed changes in engines, transmissions, and chassis upon the performance of future vehicles. In addition, they reduce the number of prototypes which must be built and tested. To the advantages of low cost and high speed (when compared with prototype construction and testing), computer simulation adds two other important plusses:

1. Test conditions are constant for any series of comparisons since test routes, speeds, weather conditions, driver habits, and other factors are controlled numerically by the computer.

2. Extensive information covering varying performance conditions of engine, transmission, and chassis components can be produced. This information would be difficult to duplicate by prototype testing.

Car acceleration

Buick's analysis of car acceleration is based on a car equipped with a nonshifting torque converter transmission. (Other types of transmissions require different transmission representation — but, the method of analysis is similar.)

The end requirement for a car performance analysis is acceleration at increments of time over a particular time period. With Newton's second law of motion, this may be written as:

$$a = \frac{F_1 - R}{M} \tag{1}$$

Solution of eq. 1 requires a definition of tractive effort (F_1) and rolling resistance (R). Car mass (M) is constant. The tractive effort may be partially defined by analyzing the third member as a separate system and considering the transmission output torque (T_4) and speed (N_2) as the power source.

The universal joints, differential gearing, bearings, and brake shoe drag are all factors which contribute to the reduction of driveline efficiency and are represented by T_5. Some torque is lost in accelerating the driveline mass to a higher driving speed and is represented by $I_2\alpha_2$, where I_2 is the driveline inertia corrected to driveshaft speed. G is the axle ratio and L_4 the rolling radius. The potential accelerating force may then be written:

$$F_1 = \frac{T_4 - T_5 - I_2\alpha_2}{L_4} G \tag{2}$$

The total rolling resistance force (R) is considered to include tire rolling resistance, air drag of the body and chassis, and churning of air by the wheels. These factors are weighted by the constants in empirical eq. 3.

$$R = 0.012\, W + 0.00085\, AV^2 \tag{3}$$

W is total car weight, A the frontal area, and V the car velocity. The solution of eq. 2 and 3 requires mathematical representation for T_4, T_5, α_2, L_4, and V. Transmission output torque (T_4) can be

* Formerly with GMC.

represented as the product of transmission input torque (T_3) and transmission torque ratio (TR).

$$T_4 = T_3 \cdot TR \tag{4}$$

The representation of driveline losses (T_5) is simplified by using an empirical equation which assumes that the losses are a function of load and speed. The constants in eq. 5 were derived from data taken from a 1957 Buick third member.

$$T_5 = 0.04\, T_4\, (2 + 0.00105\, N_2) \tag{5}$$

The driveline acceleration (α_2) is defined as a derivative of driveline speed with respect to time.

$$\alpha_2 = \frac{dN_2}{dt} \tag{6}$$

Tire rolling radius (L_4) is affected by centrifugal force acting on the tire and the weight transfer to the rear tire during acceleration. In eq. 7, test data is used to define tire growth at road load speeds and the tire normal force (F_4) is computed in a separate equation.

$$L_4 = f(V) - \frac{(F_4 - F_I)}{K_T} \tag{7}$$

In eq. 7 F_I is rear tire curb weight and K_T the tire spring rate. The value of velocity (V) at the end of a particular increment of time is equal to the velocity at the end of the previous time increment plus the increase due to acceleration during the current (nth) time increment. In equation form, this appears as:

$$V = V_{n-1} + \int_{n-1}^{n} a\, dt \tag{8}$$

Eq. 4–8 require equations for transmission input torque (T_3), transmission torque ratio (TR), driveline speed (N_2), and normal force on the rear tire (F_4). The fact that a torque converter can only absorb a specific torque for a given input speed becomes a valuable tool in analyzing the converter input torque (T_3). This value of input torque is a function of the individual converter and is usually expressed in terms of a capacity factor (K) defined as:

$$K = \frac{N_1^2}{T_3} \tag{9}$$

where N_1 is the converter input or engine speed. It is assumed, for simple representation, that eq. 9 is true for all values of converter input torque. This relationship is now used as:

$$T_3 = \frac{N_1^2}{K} \tag{10}$$

for analyzing the converter input torque (T_3). Transmission speed ratio is common to transmission torque ratio and capacity factor in a given converter design and is considered input data in a given analysis. Transmission torque ratio is defined as a function of speed ratio.

$$TR = f(SR) \tag{11}$$

Drive shaft speed (N_2) is a function of rolling radius (L_4), car velocity (V), and axle ratio (G) and is written as:

$$N_2 = \frac{V}{L_4} G \tag{12}$$

Eq. 12 was reduced to this form when the following less significant factors were eliminated from the equation:

1. Due to the Buick third member design, reaction forces at the torque ball tend to lift the sprung mass during acceleration.
2. When driving under load, the tire creeps with respect to the road surface, affecting the driveshaft speed.

Equation 13 is used to compute the normal force on the rear tire (F_4).

$$F_4 = \frac{WL_3 + F_1L_5}{L_6} \tag{13}$$

In eq. 13 L_3 is the horizontal distance from the car c.g. to the front axle, L_5 the vertical distance from the front axle to the car c.g., and L_6 the wheel base.

The solution of eq. 9–13 requires values for engine speed (N_1), transmission capacity factor (K), and transmission speed ratio (SR). The value of engine speed (N_1) at the end of a particular increment of time is equal to the speed at the end of the previous time increment plus the increase due to acceleration during the current (nth) time increment as shown by:

$$N_1 = N_{n-1} + \int_{n-1}^{n} \alpha\, dt \tag{14}$$

The transmission capacity factor (K) is by definition a function of transmission speed ratio and is shown as:

$$K = f(SR) \tag{15}$$

Speed ratio is defined as the output speed (N_2) divided by the input speed (N_1). The speed ratio is therefore expressed as:

$$SR = \frac{N_2}{N_1} \tag{16}$$

Eq. 13–16 can be solved with an expression for engine acceleration (α_1). In analyzing the torque which is accelerating the engine mass, the maximum value of torque for a given engine speed is limited by the engine torque characteristics. The transmission has the ability to absorb only a given amount of torque, again depending on design characteristics. In addition, engine accessories (such as power steering, air conditioning, generator, water pump, and fan blade) subtract from the total engine torque leaving the remainder to accelerate the engine mass to a higher speed. Transmission spin losses are included with the engine accessories. The total engine inertia includes all engine components which rotate or reciprocate with the crankshaft plus the components of the torque converter which are attached directly to the engine flywheel. If total engine torque output is designated as T_1, the total accessory torque as T_2, transmission converter torque as T_3, and the total engine inertia as I_1, the equation for engine acceleration appears as:

$$\alpha_1 = \frac{T_1 - T_2 - T_3}{I_1} \tag{17}$$

Engine torque and engine accessory torque are used as input data and are defined as functions of engine speed:

$$T_1 = f(N_1) \tag{18}$$

$$T_2 = f(N_1) \tag{19}$$

All factors in eq. 1–19, variable and constant, have

been expressed such that the equations may be solved for acceleration.

An indication of the total distance traveled can be obtained from the following for the current (nth) time increment:

$$X = X_{n-1} + \int_{n-1}^{n} V\,dt \qquad (20)$$

The preceding equations provide a practical mathematical representation with a sufficient degree of accuracy for experimental engineering work. The equations do not represent all of the factors which are known to have some effect on car performance. However, it is assumed that those factors which have been eliminated do not all add up in any one direction and, therefore, are considered to be of little significance.

Fuel economy

Fuel economy analysis requires that the following conditions be defined for computing car fuel consumption in terms of miles-per-gallon on a specific route:

1. Variations in route grade as a function of distance.
2. Velocity of the car as a function of time. Car acceleration is computed at any point on the route by differentiating car velocity.

The highway fuel economy calculation involves the problem of summing up all fuel consumed by the engine while the car is engaged in varying rates of acceleration at varying velocities on many different grades. The problem may be examined in three parts:

1. Defining the performance of the car while on the route in terms of total time spent at stabilized conditions of operation.
2. Computing the rate of engine fuel consumption at the defined conditions.
3. Obtaining a summation of all fuel consumed from the total time spent at different operating conditions and the corresponding rate of fuel consumption.

Car performance

The varying conditions of car performance on a given route can be analyzed in two categories:

1. A special case of zero acceleration can be extracted as an array of constant car velocities and constant road grades.
2. All values of car acceleration can be reduced to a three dimensional array of constant car accelerations at constant car velocities on constant road grades.

The second category can further be simplified by converting all car accelerations to a series of constant velocities on constant grades. This is accomplished by computing a grade which has a downhill force vector acting on the car equal to the force accelerating the car. This "acceleration grade equivalent" can then be added to the road grade, using trigonometric functions, and the problem is reduced to one of analyzing a series of road load conditions on a large number of constant road grades.

Road load engine fuel consumption

Automobile road load fuel economy in terms of miles-per-gallon is computed in two basic categories:

1. A calculation of required engine speed and torque for a given car speed.
2. A calculation of resulting engine fuel consumption in terms of miles-per-gallon.

The road load engine power requirements are based on the assumption that the required tractive effort (F_1) is equal to the car rolling resistance (R) for a given car speed and grade. This is represented in eq. 21 and 22.

$$R = 0.012\,W + 0.00085\,AV^2 \qquad (21)$$

$$F_1 = R \qquad (22)$$

The required transmission output speed (N_2) and torque (T_4) can be found with computed values of normal rear tire force (F_4), tire rolling radius (L_4) and drive line losses (T_5). Eq. 23–27 represent these.

$$F_4 = \frac{WL_3 + F_1 L_5}{L_6} \qquad (23)$$

$$L_4 = f(V) - \frac{(F_4 - F_1)}{K_T} \qquad (24)$$

$$N_2 = \frac{V}{L_4} G \qquad (25)$$

$$T_5 = 0.04\,T_4 + (2 + 0.000105\,N_2) \qquad (26)$$

$$T_4 = T_5 + \frac{F_1 \cdot L_4}{G} \qquad (27)$$

With given transmission converter characteristics, eq. 28–30 are used to determine the engine speed (N_1) and torque (T_1) requirements.

N_1 = (guess for iteration on eq. 28–30)

$$SR = \frac{N_2}{N_1} \qquad (28)$$

$$TR = f(SR) \qquad (29)$$

$$T_3 = \frac{T_4}{TR} \qquad (30)$$

$N_1 = \sqrt{T_3 K}$ (Check for completion of iteration where $K = f(SR)$)

After the engine power and speed have been computed for a given car velocity and grade, the rate of fuel consumption is obtained from a series of engine dynamometer fuel rate curves. Knowing the rate of fuel consumption, car velocity, and fuel density, the road load fuel consumption can be computed in miles-per-gallon. Due to the large volume of data required to define engine fuel consumption for all phases of engine performance, all engine fuel rate curves are plotted by a graph-plotting machine with input taken directly from dynamometer data. The machine-plotted fuel rate curves are used as computer input data for fuel economy calculations.

Route fuel summation

The technique for computing automobile highway fuel consumption consists of four steps:

1. obtaining a mathematical definition of a route and the behavior of a car while driving over the route,
2. converting all car accelerations on the route to a series of equivalent constant velocities on constant grades,
3. applying the road load fuel economy analysis to the series of constant velocities on constant grades and obtaining the total fuel consumption for the entire route and,
4. computing the route fuel economy in miles-per-gallon knowing the route distance and total fuel consumed.

The first step is accomplished by recording certain data at small time increments while driving an instrumented car over the specified route. This data includes road grade and car velocity as a function of time.

The second step involves taking the data as obtained from the instrumentation, differentiating velocity to get acceleration, and computing equivalent grades for each increment of time. This information is then assembled into an array where the abscissa refers to constant car velocity, the ordinate refers to constant road grade and the magnitude of data in the array is car operating time at the respective velocity grade condition. The array is produced by a digital computer from instrumentation data.

Steps three and four consist of analyzing every point in the route matrix with the road load fuel economy analysis and obtaining the total fuel consumption for the entire route.

Instrumentation for road test data

The route data required to define car performance on a particular route is recorded continuously on magnetic tape while a car is driven over the route. The tape recorder has two channels. One channel is used to record car velocity, while the other records road grade. Time is a function of tape speed.

The velocity signal is taken from a magnetic pick-up which is excited by a gear driven by the transmission output shaft. The velocity signal frequency is recorded directly with suitable amplification. The position potentiometer of a vertical gyroscope is used to provide a dc voltage proportional to road grade. This voltage signal is put through a voltage-to-frequency converter for recording on tape.

The tape recording is played back in the laboratory to obtain data in digital form. An electronic counter and a digital recorder produce printed output from the frequency signal. The digital read-out of car velocity and road grade is taken at equal increments of time. This data is punched on IBM cards and processed by a digital computer which produces a route analysis matrix.

The operation of instrumenting a car and recording a route is a one-time job, because a route matrix can be used to define a route for any combination of components providing that the combination has the performance capacity to drive the route at the velocity specified.

To Order Paper No. 196A . . .
from which material for this article was drawn, see p. 6.

Adhesive and cohesive forces advantageous in

Zero *g* Space

Based on paper by

Capt. Robert A. Trusela and Robert G. Clodfelter

Wright Air Development Div.

NEW ZERO *g* tests are revealing the importance of adhesive and cohesive forces on fluid heat transfer problems for space vehicles. Transparent boilers and condensers, built by WADD and Thompson Ramo Wooldridge, give visual evidence of the effect of these forces when a test rig is flown in a zero *g* Keplarian trajectory.

Film boiling will predominate in a zero *g* environment rather than the more normal nucleate boiling observed under gravity conditions. In fact, it is only at high heat transfer rates that film boiling occurs at room conditions. (An example is a drop of water dancing on a very hot skillet.) However, under zero *g* conditions, film boiling probably will occur immediately when the cohesive force of the fluid is greater than the adhesive force between the fluid and the heating surface. Even when the cohesive force is less than the force of adhesion, the transition to film boiling should occur at a very low rate of heat transfer. This is shown graphically in Fig. 1. Also shown is the fact that the slope of the heat transfer curves may be less for zero *g* condition due to the reduction of convection currents.

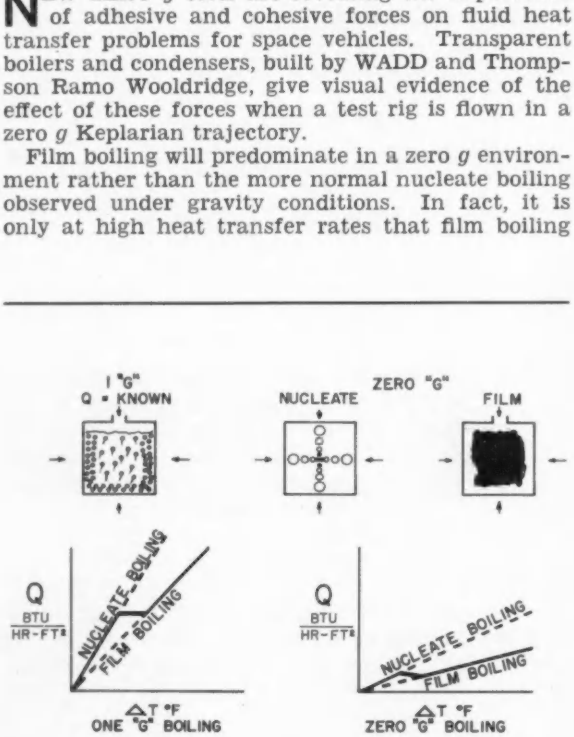


Fig. 1 — Film boiling will predominate in zero *g* space vehicle boilers. The heat transfer rate is lower for this condition since beneficial convection effect will be missing in a zero *g* environment.

Vapor bubble behavior in a liquid was simulated by inserting a tube in a plexiglass container filled with approximately 95% water, and flowing air through the tube. Repeated zero *g* tests showed:

1. The expansion space at the top of the tank intermixed with the fluid, forming a large bubble. This bubble floated randomly about the tank during the test run.

2. Smaller bubbles formed by air passing through the tube also floated randomly about the tank. (See Fig. 2.) The bubbles are not spherical because of small accelerations occurring during the test.

3. Bubbles coming into contact would bounce off each other and continue on their random paths. It was first expected colliding bubbles would burst and form larger bubbles.

4. The surface tension of the water was reduced to force colliding bubbles to burst, but the effect instead was to have the bubbles cluster together like a bunch of grapes. However, the size of the bubbles produced was smaller with the low surface tension water.

The device to be used for complete observation of boiling and condensing zero *g* operation is shown in Fig. 3. An aluminum-pyrex boiler is heated by a submerged 100 v-75 w Pyrostat-controlled heating element. Vapor passes through clear Tygon tubing into a pyrex condenser, which is cooled by air from a

Boilers

Fig. 2 — Bubbles didn't combine in fluid orientation tests conducted at zero *g*. Tests were carried out over a range of surface tensions.

dry ice chamber. The condensate is collected and measured in a graduated cylinder and passes through a valve into the hot well. A hand pump is used to force water back into the boiler. The boiler, condenser, and pump are readily removable to permit changing components during the test program. Ground tests conducted on the rig show stable operation. The rig has a motion picture camera, which simultaneously records boiler and condenser performance. Future tests will include different condenser designs, an expulsion bladder pump, and a heated screen in the boiler outlet to prevent carryover of liquid into the condenser.

Mercury condensing tests

Visual condensation tests at zero *g* were made with mercury. The boiler discharge temperature was set at 500 F and vapor velocities are estimated at 100 fps. An interface was built up in the condenser by closing the return valve. Observations of note are:

- There was a definite demarcation between the subcooler and condenser region.
- Condensate droplets were either suspended throughout or fell to the bottom of the condenser tube. Falling droplet might be due to aircraft accelerations or the fact that the tube was cooled from below.
- Without gravity force, mercury drops could cover the whole tube cross-section and cause condenser slugging or carry foreign gases through the subcooler to the pump.

There was some flow of liquid mercury toward the boiler. It is felt that this is caused by trapped gases in the condenser pressure gage line, which expanded when the mercury pressure head was removed during zero *g* operation.

To order Paper No. 154C . . .
from which material for this article was drawn, see p. 6.

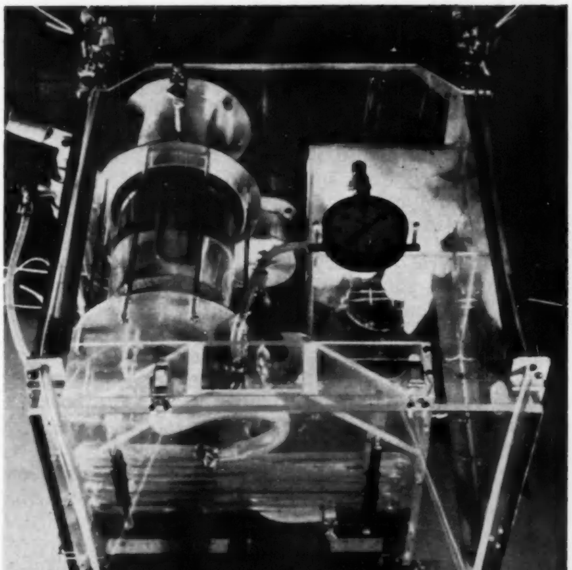


Fig. 3 — Completely transparent test rig is used to study boiling and condensation during zero *g* operation. The rig is mounted in an airplane which flies a Keplarian trajectory.

Revolutionary Advances Predicted for Materials in the '60s

Aluminum Use To Double In 5 Years

J. H. Dunn
Aluminum Co. of America

IT is believed that the average use of aluminum in passenger cars will double within five years. This belief appears justified in view of the following industry developments:

1. There has been a strong trend toward increased use of aluminum in U. S. passenger cars for applications other than engines. The average use of aluminum was about 35 lb per car in 1956, compared with about 56 lb per car in 1960. This is an increase of 60% in only four years.
2. An engine using many aluminum components has been introduced by Chevrolet in 1960, and it is expected that other aluminum engines will appear in the near future, probably in 1961 models.

Let's look into our crystal ball and see what potentialities exist for aluminum in future U. S. cars.

The justification for aluminum brake drums is reduced unsprung weight and better performance. Aluminum brake drums are used extensively in Europe with excellent results. In the future they may receive greater attention from U. S. manufacturers.

Aluminum bumpers are used to some extent in Europe — just as aluminum bumpers have been widely adopted in this country for trucks and buses. Laboratory and field tests have shown that the aluminum bumper will withstand impact satisfactorily and that jacking loads are not a problem. Important weight savings can result. For example, an experimental bumper produced in this country showed a savings of about 32 lb. Also, an anodically coated aluminum bumper actually costs less than a chromium-plated steel bumper even though the aluminum section is increased slightly in some areas to give satisfactory stiffness.

Aluminum radiators under test today are lighter and potentially cheaper to build than the radiators now in use. Several thousand of these radiators have been undergoing road tests under all types of operating conditions. The service results have been satisfactory.

Well over 150 million pounds of aluminum automotive trim are now in service. Substantial improvement in anodized finishes has taken place. Further improvement in light-fast colored anodized finishes is anticipated so that within the next few years car designers will have much more latitude than they do today in specifying colored aluminum finishes.

The use of aluminum engines in both compact and full-size cars will increase. To take full advantage of the possibilities of the aluminum engine a new car is required — not just a redesign of an existing car in which a cast-iron engine is replaced by an aluminum powerplant. Potential weight savings in the frame, suspension, brakes, wheels, tires, engine supports, and other members are possible where all of the design possibilities are fully exploited. This is why aluminum engines will most likely be associated with new car designs of the future — not 100% new cars, perhaps, but certainly extensively redesigned cars. An aluminum engine should be part of a new, complete package — not just a substitute for a current engine made of cast iron.

Bright Future Seen For Plastics

J. D. Young
E. I. du Pont de Nemours & Co., Inc.

TWO new components for cars, released for production on the 1960 models, represent significant breakthroughs for plastics and suggest greater use of plastics in future cars. The new components: windshield washer pump, and seat side shield.

The injection molded windshield washer pump body is unusual in several respects:

1. The part was designed specifically for production with Delrin acetal resin.
2. The particular design could not have been made as effectively using any of the usual materials such as zinc or aluminum.
3. The part is essentially finished as it comes from the die — there is no flash to remove, no finishing operations.

Technological developments in aluminum, plastics, rubber, steel and plating are laying the foundation for unique, new passenger-car application of these materials over the next 5-10 years. This article lets you know just what's happening.

4. The part is completely unaffected by any of the windshield wiper solvents and will withstand temperatures to 250 F or higher. It has a fine surface finish, and if for any reason one wanted a colored windshield washer pump body, this could be done.

5. From an economic standpoint, the pump body is competitive with a die-cast part. Tooling costs are comparable and die maintenance costs are far less than when die-casting techniques are used.

This application illustrates the opportunity available to the automotive designer who takes full advantage of the properties of the newer plastic materials and designs the part from the beginning with the properties of the particular plastic in mind.

The second plastic advancement is the side shield used in the 1960 Ford line. Here, one of the newer plastic materials, linear or high-density polyethylene, replaced a steel stamping. As before, the part is designed specifically for the properties of the plastic material. The features of this application are:

1. The tooling costs and individual piece price are only about two-thirds that of a steel part.

2. By virtue of the injection molding process, it was possible to make the plastic shield with a partly grained and partly smooth surface with design features in crisp, sharp relief. This type of styling could not readily be produced in a painted steel stamping.

3. The plastic part provides a weight saving of 2.8 lb per car.

4. Because of the graining, and the fact that color is an integral part of the material, scuff resistance is superior to painted steel.

5. Because of its resilence, the plastic material does not dent as readily as steel (over a temperature range of -20 to 200 F).

Recently, two additional plastic applications for U. S. passenger cars have aroused much attention — the use of plastics for bearings and fuel lines.

Current interest in reducing the number of grease fittings — to permit a greased-for-life car — has stimulated interest in the use of plastics. In fact, one U. S. car producer has introduced a steering linkage using nylon as a bearing material. There will be similar applications on 1961-model cars.

Interest in nylon fuel lines is growing. Extensive tests in the laboratory and in the field indicate that resistance to fatigue and corrosion are superior to metal lines, with other properties being entirely satisfactory. There have been successful applications of nylon fuel lines in specialized trucks where production volume is small. Here, the ability to route a fuel line through almost any available opening is a distinct advantage. The problem is primarily one of economics. If steel prices should rise, changing the present economic balance, there may be considerable additional interest in this application.

While plastic body panels are often not economically feasible for high-production cars, the possibility of development of some new plastic material for this use coupled with new fabrication techniques should not be overlooked. For example, polycarbonate materials have recently been announced which are said to be capable of cold forming. This, of course, raises the possibility that body panels might be formed of plastic in the same equipment presently used for steel.

Fabrication Aids Tomorrow's Steels

M. F. Garwood

Chrysler Corp.

RECENT developments in cold forming and heat treatment insure steel's place as a leading engineering material in tomorrow's automobiles.

Cold forming methods of fabrication will advance as larger presses, improved dies, better die lubricants, and improved technology become available. They will replace many hot forging and machining operations. Less steel will be required because of lower scrap losses. More critical quality requirements will be met through freedom from seams, uniformity of microstructure, response to heat treatment, and control of carbon. (Cold forming of higher carbon steels is now increasing through the use of proprietory annealing cycles.)

Considerable development work is being done on the cold extrusion of steel. Extrusion of carbon

steel shafts produces a product with cold worked core properties equal to the cores of many heat-treated alloy steel shafts. Selective hardening is used to give required surface hardiness without affecting core condition.

Two interesting developments in the heat treatment of steel have come about recently: expanded usage of carbonitriding and suspended carburization.

Carbonitriding permits the replacement of many carburized alloy steels with carbon steel. Furnace maintenance costs are reduced through lower operating temperatures and leaner gas mixtures. Contributing to the success of carbonitriding are improvements in plain carbon steel mill practice and furnace control devices. Consistent steel analysis and close control of furnace variables will continue the trend toward greater usage of carbonitrided carbon steels.

Suspended carburization consists of holding parts for an extended period of time in a carburizing atmosphere without altering the carburized characteristic of the parts being treated. This is accomplished by employing atmospheres neutral to the steel being treated at reduced temperatures. An economic advantage exists in the elimination of time required to unload and load furnaces.

Corrosion Tests Improve Coatings

C. F. Nixon
General Motors Corp.

THE outstanding technological breakthrough in recent years in the field of decorative plating has been the development of two practical, reliable, accelerated corrosion tests. It is now possible to learn quickly and with reasonable assurance how a plated article will look after about a year of service on the outside of an automobile. These two tests, the Corrodkote test and the CASS test, are the result of nearly 10 years of steady effort in various laboratories, coordinated by the American Electroplaters' Society Research Project No. 15 Committee.

Within the past two years, one or the other of these new tests (or both) has been adopted by nearly everyone concerned with either the production of, or the purchase of, chromium-plated components intended for use on automobile exteriors. The tests are now being used to guide research and development work on plating systems of enhanced durability, and to control quality on the production line and in the receiving department. Proving again the worth of valid measurements, the result is definite improvement already realized and a reasonable promise of still better things to come.

The two most noteworthy of the changes that have been made in plating practice by many, largely as a result of test findings, are: duplex nickel and heavier chromium.

Duplex nickel is the substitution of two layers of nickel, one directly over the other without intervening plating, for one continuously deposited layer of bright nickel. In current practice, the first layer of a duplex nickel coating is semibright in appearance and plated from a solution containing organic additives that bring about leveling, that is, cause nickel to deposit somewhat more rapidly in surface microvalleys than on surface micropeaks, so that the resultant surface is smoother than the starting surface. The second layer, preferably about half as thick as the first, is usually bright nickel plated from a bath containing organic additives which may or may not induce leveling but which do, probably through their influence on the grain structure of the deposit, cause the surface of the plated nickel to increase in brightness (up to a point) as its thickness increases. The practical value of nickel plating that levels and brightens the starting surface is that it minimizes or perhaps eliminates the need for buffing. Actually, it was for this purpose that duplex nickel was first developed. Knowledge of its usefulness as a means for enhancing durability came later — slowly at first, then rapidly with widespread adoption of CASS and Corrodkote.

All duplex plating of nickel is not equally effective in promoting durability. Present thinking is that this property is dependent upon the nature of the organic additives used in the two plating baths. It seems that best results are obtained when the additives used in the first bath do not contain sulfur and when at least one of those used in the second bath does. The explanation is that when sulfur-containing additives are used, a small amount of sulfur finds its way into the nickel deposit, making it relatively more susceptible to corrosion attack. However, it has been demonstrated that when a corrosion pit penetrates the outermost layer of nickel and reaches the sulfur-free layer of nickel beneath, it tends to stop deepening and becomes wider instead. In other words, the outermost, more active layer of nickel, in a system of this sort, provides a measure of anodic protection for the innermost layer. At any rate, it seems true that duplex nickel systems in which both layers of nickel contain sulfur or in which neither contains sulfur are not as effective in retarding the beginning of metal corrosion.

The other noteworthy change in plating practice is the use of heavier chromium. Chromium, in thicknesses greater than 0.000010 in., can contribute significantly to the overall durability of the plating system. Thicknesses up to 0.000150 in. have been recommended and most platers are striving now for at least 0.000030–0.000040 in.

Unfortunately, electrodeposited chromium is very brittle and usually has residual tensile stress of considerable magnitude. Therefore, it is prone to visible cracking in heavier thicknesses. To restrain this tendency, and also to gain the thickness desired for improved durability, a number of changes in chromium plating have been proposed having to do both with the composition of the chromium-plating bath and with its method of operation. Thus platers now talk more about high-temperature, high-ratio baths (about 130 F, chromic acid to sulfuric acid

ratio greater than 100/1), surge plating, and dual (or duplex) chromium. In surge plating there is a periodic change in current density from one that is relatively high to one that is relatively low. By dual chromium is meant the plating of two successive layers of chromium, one directly over the other, from different chromium plating baths. Each of these devices for attaining heavier chromium plating thicknesses without excessive cracking has its proponents. The situation, perhaps, is too new to permit a valid statement as to which method for plating heavier chromium is best.

Much has been published on the operation of both the CASS and Corrodkote tests. The CASS test is a modification of the now discredited neutral salt spray test; the word CASS is a contraction of its longer name, the copper chloride modified acetic acid salt spray.

The Corrodkote test is a refinement of an early prototype in which melted Detroit street slush was splashed on plated parts by means of a rotating paddle wheel. The present Corrodkote corroding agent is a slurry of Kaolin and water to which has been added 0.035 g cupric nitrate, 0.165 g ferric chloride, and 1 g ammonium chloride for each 30 g of Kaolin. The amount of water needed to make a suitable slurry is something less than 250 mm. This slurry is applied to the part to be tested by spraying or by brushing, after which the part is placed in a humidity cabinet at 90–100% humidity for 20 hr.

The question is often asked, "Why can we not select one of these two tests as a standard instead of inflicting both on industry?" This day may possibly come, but at some time far in the future. Both tests are still quite young. They have been in general use hardly more than two years. While the tests are approximately parallel, there are some points of difference that suggest that it may be desirable, particularly from a development point of view, to use both.

Tools Hold Key To Rubber's Future

G. H. Swart

The General Tire & Rubber Co.

A NUMBER of tools are available today which should lead to the preparation of new rubbers for the automotive industry. The tools: chemical modification, grafting, and stereo control.

The chemical modification of existing plastics and rubbers to give added utility, while not really new, is showing much unexpected promise. Examples are the chlorinated and brominated Butyl rubbers to permit the advantageous use of such derivatives both alone and in admixture with the highly unsaturated rubbers. There are also the Hypalon elastomers prepared by treating polyethylene with chlorine and sulfur dioxide. One can look forward to many chemical modifications of polymers with the objective of changing important characteristics, such as their solvent resistance, compatibility with with other polymers, and dynamic properties.

Another tool which is useful to the polymer chemist is grafting. With this technique, monomers are generally induced to start chain growth at various points along the molecular backbone of the starting polymer. This technique allows incompatible polymers to be chemically bound together to provide unusual properties which could not be obtained if the starting polymer and the one formed by the grafting polymer were prepared separately and then mechanically mixed together. There is little question that the grafting technique will provide many compositions of commercial value in the future.

Although the two mechanisms described hold the promise of providing new elastomeric substances of great value and usefulness, the significant advances in the future probably will have their basis in the control of the stereostructure of such materials.

By the use of special catalysts, it is possible to control the spatial arrangement of the atoms in a polymer during its growth. This new control of polymerization, called stereopolymerization, is responsible for the synthesis of synthetic natural rubber and of previously unknown polymers such as cis-polybutadiene and trans-polybutadiene, as well as for the polypropylene structure which has such great industrial potential today. For the first time there are catalysts which will allow important control of polymer structure. It is now becoming possible to design polymer structures much as an engineer designs the functional parts of an automobile.

The importance of this advance in polymerization control is becoming quite obvious, although there has barely been time to scratch the surface of the immense potentiality of this new technique. In the hands of imaginative technical men, it is believed to be the key to much of the future advance in both rubber and plastics. To the automotive engineer it brings closer the day when elastomeric and plastic materials can be made with controlled molecular structure and, consequently, with a balance of properties never before possible.

It may be anticipated that in years to come the engineer will have at his disposal a catalog of plastics, rubbers, and fibers rivaling the dependable performance of the metals as materials of construction. The infant field of mechanical behavior of polymers will assume a more meaningful engineering significance and the structural engineer will rely heavily on a new breed of polymer designers and architects. In this way these new polymerization techniques and other advances to come will make their greatest contribution to the engineerieng of future products.

LAYING IT ON THE LINE, materials experts forecast the future of a variety of materials at an SAE panel session on What's New in Engineering Materials for 1960.

This article is based on some of the points brought out at this session.

The complete panel discussion is available as SP-175.

■ **To Order SP-175, see p. 6**

12 Point Program for Reliability

. . . engineer's approach to design and testing determines product's reliability

Abridgment of an SAE Buffalo Section Paper by

C. V. Crockett

Truck and Coach Div., GMC

PRODUCT RELIABILITY depends upon the engineer's approach to and interest in the problem. This interest must begin with the product's inception and continue through its final production stages. A program for reliability should include the following steps;

1. Determine product needs

Initially an engineer must determine the kind of reliability the product needs. For example, pleasure cars should be reliable, but must be produced at a relatively low cost; furthermore, operation for extended mileage is not required. On the other hand, the first cost of heavy-duty trucks and buses is not objectionable if it reduces the overall expense by reducing the operating cost — so high mileages are expected and received. Obviously, the reliability requirements for passenger cars will not satisfy the fleet operators, and vice versa.

2. First cost + maintenance = minimum

For commercial vehicles the engineer should determine the yearly operating mileage, and multiply it by the years of use to determine the overall mileage expected by the fleet operator. Then, designs and materials should be selected so that the first cost plus the maintenance cost will be a minimum.

3. Simplicity

Obviously, the simpler the design, the fewer parts it has, and the fewer steps required in its manufacture, the more reliable the final product will be.

4. Realistic specifications

An attempt to secure very high performance frequently results in poor reliability. Sometimes, performance specifications can be met only at the sacrifice of reliability.

Fig. 1 contrasts two designs, one of which will perform 100% if in perfect condition. Because it is complex, however, there is some deterioration due to engineering errors, the average performance is lowered more by manufacturing and assembly errors, and the maintenance will be less than 100% because some mechanics will not understand the complicated mechanism. The result is an average realization of desired performance specifications of about 70%.

The right hand bar of Fig. 1 illustrates what might be expected of a simpler device which, because it's relatively crude, achieves a maximum of only 90% of the optimum performance. However, because it's simple, the people in the departments involved made fewer mistakes, resulting in an average performance of 80% — better than that secured from the more complicated mechanism.

5. Reduced maintenance requirements

The less maintenance required, the less opportunity there is for human error — and the more reliable the vehicle. For example, in the commercial field it is desirable to provide large enough fuel tanks and low enough oil consumption so that an intercity coach can run from one terminal to another without refueling or additional lubricants. No matter how careful an organization is in training its people, it seems very difficult to avoid not adding lubricants when needed, putting in too much, or putting them in the wrong filler pipe.

As durability and reliability improve, an improvement in maintenance reliability becomes increasingly important. If an automotive mechanism is capable of running several hundred thousand miles before overhaul, then it becomes almost inevitable that that mechanism will fail due to some accident such as loss of coolant, loss of lubricant, or failure to add lubricant. Many such accidents occur during or due to mistake made in routine maintenance.

6. Make foolproof

There are many different kinds of fools in the world and they can think up many varieties of foolish things to do. The engineer must know the type of fools which predominate in his field and be prepared to guard against them. For example, in the design of pleasure cars the engineer should design so that the mechanism will survive a certain amount of carelessness. In military usage, soldiers sometimes will attempt to put a machine out of operation because a deadlined vehicle gives them time off — the engineer must design accordingly.

7. Design for easy manufacturing

The engineers can improve reliability by designing the machine for ease of manufacturing. Simplicity of design is the first step, but there are other factors involved. Consultations with the factory people are always in order during the design stages. Factory personnel should be asked to examine, assemble, and disassemble the prototype mechanism. Time in the development schedule should be allowed for revisions to improve manufacturing ease. Tolerances should always be as great as practical. The requirement for close tolerances due to dimensional stack ups frequently indicates poor design practice.

Some large engineering departments correct this difficulty by having separate development and production engineering departments. Another approach is to make sure the process engineers and the production and inspection people see the drawings as they are prepared, that these people understand what is expected of the mechanism, and that they insist on adequate dimensioning of the drawings.

8. Test

The best way to improve reliability through testing is by carefully planning and scheduling the test program. Everybody involved should be consulted, the test program planned, reduced to writing, and scheduled. Planning will permit thorough testing without prohibitive costs. Production devices are sometimes unreliable because the experimental department mechanics are too good. They make test devices operate satisfactorily and later the same mechanism fails in the field because of lack of expert attention. Following the engineering evaluation and durability testing, field testing is highly desirable. Field testing is generally less expensive, will add information that cannot be secured otherwise and, at least in the case of heavy-duty trucks and buses, will secure mileage more rapidly than on a proving ground.

General Motors has found field testing more valuable when the vehicles are sold rather than loaned to operators. When an operator has his own money in a vehicle his comments are much more pointed.

9. Correct deficiencies quickly

There are always deficiencies which cannot be found during the test period and which show up in early production. Making these corrections quickly requires a highly skilled, well-developed organization. There must be people in the field who can recognize the deficiencies quickly, analyze them properly, and get the information to the engineering department. Correction by the engineering department often involves complicated testing procedures, plus a high degree of judgment, and most important — *action.*

The reliability of a new product can be improved by limiting changes to those required to correct deficiencies which adversely affect reliability. Improvement changes, cost reduction changes, and the like should be deferred. When the deferred changes are put through later, they should be put into production as a group, because experience has shown that reliability suffers less from a group of simultaneous changes than when changes are spaced so that production does not have a chance to settle down between the successive disturbances.

10. Correct the deficiency once and for all

When a deficiency becomes apparent, the engineer should not be so eager to correct it that he does an incomplete job. He should be sure he has as many facts as possible before taking the necessary action.

The conflict between steps 9 and 10 must be met by compromise — compromise guided by common sense.

11. Quality control

Quality control is very largely due to the engineering department's attitude. If quality control is a fault in a plant, the fault may be attributed to the engineer's lack of interest. The best engineer does not hide his own mistakes behind claims of factory errors. Quality control is improved when the engineering and manufacturing departments cooperate.

12. Organize for reliability

The placement of a reliability engineer in the organization is one way to recognize the problem. All engineers should be given an opportunity to see the results of unreliability — through product use, field trips, and the like. In this way, he will be more alert to the problem.

To Order Paper No. S245 . . .
from which material for this article was drawn, see p. 6.

Fig. 1 — Simplicity of design is a major reliability requirement.

Round-up of cryogenic fluids for

Missile and space propulsion

Liquid fluorine-liquid hydrogen gives highest thrust system . . . though liquid oxygen-liquid

Based on report presented at meeting of SAE Committee AE-5, Aero-Space Fuel, Oil, and Oxidizer Systems of the Aero-Space Equipment and Propulsion Divisions

by Dr. Edward L. McCandless
Linde Co., Division of Union Carbide Corp.

Liquid fluorine

Fluorine is the most powerful oxidizer known. It produces the highest flame temperature and specific thrust when used with liquid hydrogen as a fuel. This combination is already being successfully fired in medium sized rocket engines at test bases.

Toxicity is presently a limiting factor on its choice as an oxidizer . . . plus the close approach of liquid oxygen-liquid hydrogen systems to its performance (about 95%). Even in low concentrations and for exposure times not considered seriously toxic, human contact with fluorine is extremely painful.

Chemically, fluorine is hypergolic with most hydrocarbons, liquid hydrogen, and most powdered metals. Nickel or nickel alloy, passivated with HF, is the principal material used in fluorine system construction. Fluorine is transferred by helium pressure or nickel-trimmed pumps and almost always transported in tankage with liquid nitrogen as a jacket.

The physical properties are:

Boiling point	– 188 C at 1 atm
Critical point	– 129 C at 810 psia
Density	12.6 lb/gal at bp
Vapor pressure at – 196 C (bp of N_2)	5.7 psia

Liquid oxygen

Liquid oxygen is the largest tonnage cryogenic material, with military and space usage about 1000 to 2000 tons per day. The bulk of this usage goes to development test firing of ICBM and space-vehicle engines, such as the Saturn. Although solid fuel propellant usage is growing, liquid fueled engines seem sure to dominate the large space booster field.

Kerosene type fuels are still the most common, but the hydrogen-oxygen combination is rapidly gaining. This combination doesn't have the toxic problems of fluorine, yet still retains nearly the same specific thrust. Liquid oxygen is hypergolic only with a few special fuels such as aluminum triethyl and pyrophoric iron powder.

Aluminum, copper, or stainless steel (with silver-soldered or welded joints) is used to contain or handle this – 183 C liquid. Carbon steel is brittle at this temperature. Plastics are brittle and combustible in liquid oxygen. "Kel-F" and "Teflon" fluorinated plastics are exceptions, but they too must be used with care.

The physical properties are:

Boiling point	– 183 C at 1 atm
Critical point	– 119 C at 740 psia
Density	9.5 lb/gal at bp

Liquid hydrogen

Hydrogen is the highest energy fuel for chemical rockets. It potentially is the fuel for the upper stages of all large space vehicles, but its low density precludes its use in the first stage.

The 40% higher specific thrust of liquid hydrogen permits greater payloads in orbit. As a comparison, using oxygen as the oxidizer, hydrogen has a heat of combustion of 50,000 Btu/lb, hydrocarbons have 20,000 Btu/lb, and boranes, 30,000 Btu/lb.

Liquid hydrogen has just become available in bulk commercially, although the Air Force operates several tonnage plants.

Test firing with oxygen and some fluorine has

systems

specific

hydrogen is close contender.

been extensive, with remarkably few problems with combustion, turbo-pumps, and regenerative nozzle cooling.

Chemically it is inert to essentially all handling and container materials. It is insoluble with all substances, except liquid helium. It is non-toxic.

The main problems are the physical handling and storing of liquid hydrogen.

- Its low density leads to bulky storage vessels.
- Low heat of vaporization (114 Btu/gal, or 1/8 the value for liquid oxygen) requires vacuum insulation on tanks, lines, valves, and pumps.
- It must never be exposed to air.
- High volumetric expansion as the liquid warms up above the 20 K, 1 atm boiling point produced ullage requirement of 10–30% in storage tanks.
- Careful sub-cooling is required at inlet to all pumps.

The physical properties are:

Boiling point	– 253 C at 1 atm
Critical point	– 240 C at 188 psia
Density	0.59 lb/gal at bp

Liquid helium

While *gaseous* helium is universally and extensively used in rocket systems, both in flight and GSE equipment, *liquid* helium is just beginning to enter the picture. It, like nitrogen, helps the system operation rather than being a fuel or oxidizer. Because of its very low boiling point, for instance, it can pressure pump liquid propellants. Being inert to all substances, there is no problem of contamination or toxicity.

Thermal insulation is the major problem with liquid helium. First its heat of vaporization is only 9 Btu/gal vs. 873 Btu/gal for liquid oxygen or 114 Btu/gal for liquid hydrogen. This makes its storing and piping far more severe than for any other cryogenic fluid. Added to this is the fact that it has the lowest boiling point, only 4 K above absolute zero.

As a result, tanks and pipes must be vacuum insulated or have a jacket of liquid nitrogen to achieve acceptable low heat leakage.

The physical properties are:

Boiling point	– 269 C at 1 atm
Critical point	– 268 at 33 psia
Density	1.04 lb/gal at bp

Liquid ozone

Ozone gives a 5–10% better rocket performance than oxygen, but there is no known process for stabilization against explosive self-decomposition. Such decomposition occurs in greater-than-30% solutions of liquid ozone in liquid oxygen. This characteristic makes it an unlikely oxidizer in the foreseeable future. In addition, it is toxic.

The physical properties are:

Boiling point	– 112 C at 1 atm
Critical point	– 12 C at 800 psia
Density	11.3 lb/gal at bp

Liquid nitrogen

Liquid nitrogen rates mention for propulsion systems because it is extensively used as an inert cold-testing and purging fluid in liquid oxygen equipment. Being inert, there are only the problems involved with its low temperature.

When exposed to air, liquid nitrogen will condense O_2 out of the air and form a solution. Since liquid nitrogen boils off preferentially, the mixture can become oxygen rich just before total evaporation. Therefore, liquid nitrogen must be handled with liquid oxygen precautions.

The physical properties are:

Boiling point	– 196 C at 1 atm
Critical point	– 147 C at 495 psia
Density	6.7 lb/gal at bp

SAE COMMITTEE AE-5, Aero-Space Fuel, Oil, and Oxidizer Systems, serves industry by creating needed specifications, up-dating existing ones, and, at semi-annual meetings, giving members and guests an opportunity to discuss pressing technical problems.

Typical of AE-5 projects are:

- **A cryogenic equivalent of MIL-F-8615 (a general fuel system component specification).**
- **Contamination in fuel systems.**
- **Fuel gaging in space vehicles under zero *g* conditions.**

Measuring process used for sound evaluation of

INSIDE surface finish of tubular products

Based on paper by

W. C. Harmon

Republic Steel Corp.

Fig. 1 — Instrument for measuring accurately the inside surface finish of tubing.

FOUR YEARS' EXPERIENCE with a procedure for measuring and evaluating the inside surface finish of tubular products indicates mutual benefits to users and producers. Developed and sponsored by the Formed Steel Tube Institute, this procedure for making microinch readings on interior surfaces of tubing revolves around the instrument shown in Fig. 1. The instrument operates by tracing the inside surface of the tubing with a diamond stylus. The stylus is carried on a skid with a radius large enough to provide a stable support unaffected by the surface variables. The radius at the tip of the stylus is so small (0.0005 in.) that the stylus rides up and down over each variable in its path. The stylus is coupled to a transducer, which generates a voltage directly proportional to the vertical displacement of the stylus.

The voltage from the transducer is amplified and fed to a meter, which registers the arithmetic average of the height of the surface finish variables. The meter is calibrated directly in microinches (millionths of an inch).

A circumferential trace is used, because good practice in surface finish analysis dictates tracing transverse to the predominate lay. Mechanical tracing is accomplished by rotating the tube sample on power-driven rolls at the correct tracing speed —

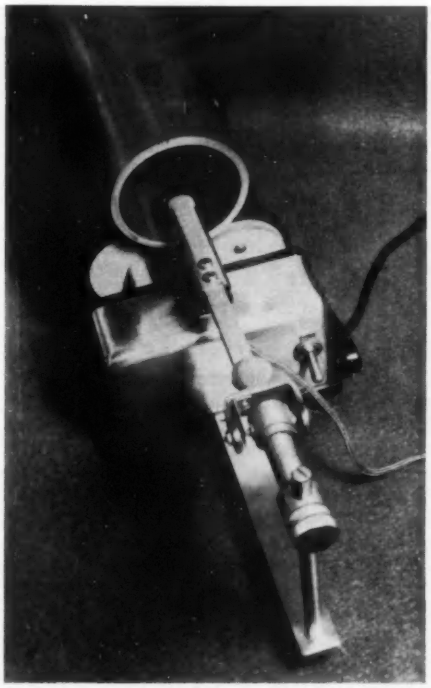


Fig. 2 — How circumferential trace is made mechanically in measuring inside surface finish of tubing.

MICROINCH FINISH

WALL THICKNESS			
0.065 AND UNDER	OVER 0.065 TO 0.150 INCLUSIVE	OVER 0.150 TO 0.187 INCLUSIVE	O. D.
			0.5 TO 2.5 IN. INCLUSIVE
			OVER 2.5 TO 4.5 IN. INCLUSIVE

Fig. 3 — Charts showing groupings by combinations of diameter and wall thickness used in procedure for measuring inside surface finish of tubing.

while a jig holds the tracer-head in proper position in the tube . . . as shown in Fig. 2.

An average of 12 readings provides a dependable, consistent rating for the overall finish. The procedure specifies ratings, which were developed from analysis of random samples gathered over a long period of time. These samples were separated into groups, based on diameter and wall thickness. For each group, distribution charts of the surface finish ratings were prepared. These revealed that certain combinations of diameter and wall thickness exhibited almost identical ranges of ratings . . . and could, therefore, be grouped together, as shown in Fig. 3.

Limits Specified

Simple limits are specified for each group of products. For each diameter of wall thickness, the maximum average microinch rating is specified, as shown in Fig. 4. Allowances have been made for variations in ratings caused by taking readings at different locations in the tube. (A variation of 35% is normal).

Experience with this procedure since 1956 indicates that additional consumer benefits can be gained if tubing having even lower ratings than those specified at present could be produced. Some manufacturers are currently working to produce such a product.

To Order Paper No. 195D . . .
from which material for this article was drawn, see p. 6.

MICROINCH FINISH

WALL THICKNESS			
0.065 AND UNDER	OVER 0.065 TO 0.150 INCLUSIVE	OVER 0.150 TO 0.187 INCLUSIVE	O. D.
40	45	55	0.5 TO 2.5 IN. INCLUSIVE
40	50	60	OVER 2.5 TO 4.5 IN. INCLUSIVE

MAXIMUM AVERAGE READINGS (MICROINCH)

SPECIAL SMOOTH ID FINISH ONLY

Fig. 4 — Limits specified for each group in procedure for measuring inside surface finish of tubing.

How springs perform above 900 F

Based on paper by

William R. Johnson and Ronald D. Crooks

Associated Spring Corp.

STRESS relaxation of statically loaded spring materials proceeds at a constant rate if the time is plotted on a log basis. (Tests were run on springs of various materials, for temperatures up to 1200 F, and also times up to 1500 hr. In all cases, the straight-line relationship held, so cautious extrapolation of test data may be justified.) Heat set springs exhibit a markedly better performance with close to zero or actually negative relaxation, but this is only a temporary effect, depending on the heat setting process.

The tests also showed Inconel X, No. 1 temper, to be the best of the commonly available spring materials, although one sample of Refractaloy 26 has given better results, particularly as the temperature rises. Unpublished data of the International Nickel Co. have indicated that spring temper Inconel X, given the triple heat-treatment of 2100 F for 2 hr, plus 1550 F for 24 hr, plus 1300 F for 20 hr, may be expected to give comparable results at these temperatures. However, the heat-treatment must be applied to already coiled springs, necessitating supporting arbors.

What the tests reveal

Fig. 1 shows data for relaxation presented as a per cent of load loss with time for given conditions of stress and temperature. This load loss figure actually represents a loss of deflection, but the two are directly proportional. The set in inches (for degrees for the wire torsion tester) divided by the test deflection times 100 is reported as a per cent load loss. The plots, which are essentially straight lines on a semilog basis, do not go through zero relaxation; the intercept at zero time would represent the initial plastic flow due to the lower yield point at the elevated temperature.

Two factors control the total amount of relaxation — the initial relaxation due to plastic flow and the time-dependent anelastic flow. Some materials show a high initial relaxation and a low rate of anelastic flow, while others are just the opposite. Thus, materials which may be best for short operating times will not necessarily be so for longer times. This condition changes with operating temperature so that some alloys, which have a high initial rate of relaxation but a low flow rate, may look increasingly better as the test temperature is increased. In Fig. 1, the alloy Haynes 25 shows a low initial relaxation but a high rate of anelastic flow at 1000 F, so that springs made of it are poorer than those of Inconel X at longer test times. The condition is accentuated above 1000 F and reversed at temperatures below 900 F.

When creep and relaxation are plotted for the same type of spring, with the same initial stress, both are shown to lose load at a constant rate on a semilog basis, but the rate of load loss is appreciably

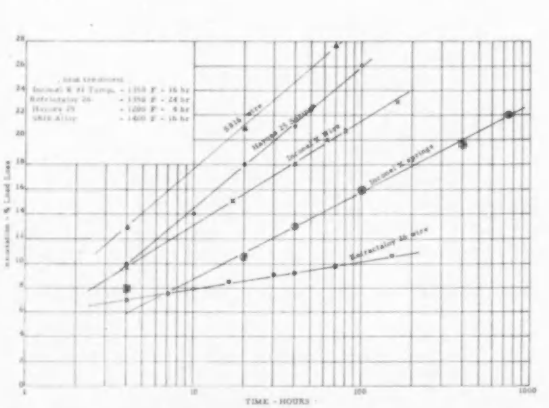


Fig. 1 — Stress relaxation of springs and straight wire specimens at 1000 F. Initial stress 40,000 psi. Initial relaxation due to plastic flow and the time-dependent anelastic flow control the total amount of relaxation. Some materials exhibit a high initial relaxation and a low rate of anelastic flow, while others exhibit the opposite. Thus, materials best for short operating periods may not be best for longer times.

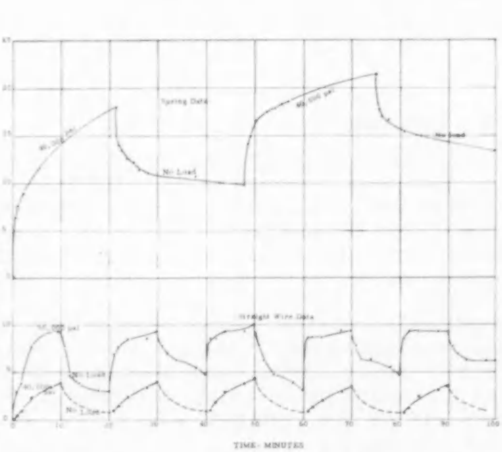


Fig. 2 — Stress relaxation and recovery of Inconel X alloy springs and straight wire samples at 1000 F. After a loading period the springs tend to recover anelastically.

higher under conditions of creep or constant load.

Fig. 2 presents relaxation and recovery data obtained by alternate loading and unloading springs at temperature. Here the significant point is the tendency of a spring to recover anelastically after a loading period. This effect is the basis for the spring heat-treating process known as heat setting in which a spring is overloaded at temperature for a short time to impart a tendency to grow or resist a lower load at temperature.

A drastically heat-set spring will actually gain load and exhibit recovery or negative relaxation during test under load if the heat-set time, temperature, and stress have been sufficiently high as compared with service stress and temperature. Of course, if a heat-set spring is unloaded at temperature it will recover rapidly. Thus, the heat-setting process is best for a steadily loaded spring and not for one intermittently loaded, although some gain may be expected due to the allowance for the initial plastic flow.

Effect of heat setting

The beneficial effects of heat setting are transient. Heat-set springs (Fig. 3) in most cases show some slight initial recovery, then a period of no relaxation, and then finally a period in which relaxation begins and proceeds at a rate equal to that of a not heat-set spring. The period of stability conferred by heat-setting may last from a few hours to a thousand, but ultimately relaxation begins as if there had been no heat-setting. The period of delay appears to be related to the severity of the heat-setting operation for a given alloy and given test conditions. Unfortunately, severe heat-setting operations result in a greater amount of initial recovery. To date, we do not know how to make a spring that will show zero relaxation indefinitely under load at temperatures above 900 F. However, this ideal can be approached if a precision heat-set spring is calibrated at temperatures to allow for any recovery.

To Order Paper No. T-44 . . .
from which material for this article was drawn, see p. 6.

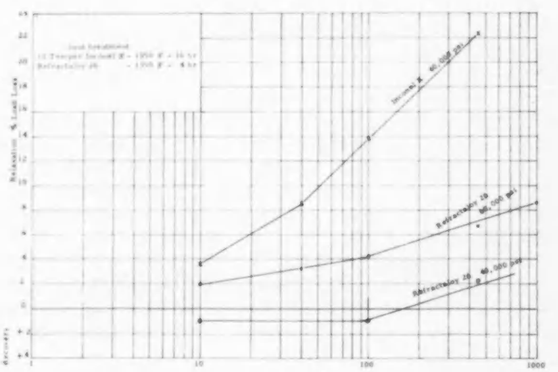


Fig. 3 — Stress relaxation of heat-set springs at 1100 F reveal the beneficial effects of heat-setting to be transient. Ultimately, the rate of relaxation equals that of a not heat-set spring.

Car Design Can Reduce Collision Injuries

Based on paper by

J. H. MATHEWSON, D. M. SEVERY, and A. W. SIEGEL

University of California

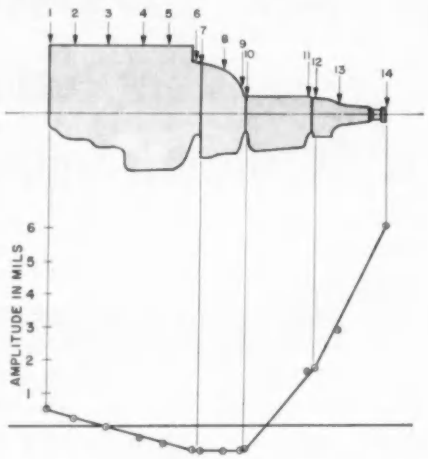
THE VELOCITY-TIME patterns by which a car decelerates to near-zero velocity has little bearing on the occupants in head-on collisions at speeds in the 20–30 mph range and this has been found to be true of collisions at 52 mph, as well. Nevertheless, protection for the motorist can be improved.

Head-on collisions at impact speeds of 23 and 32 mph, carried on with two, fully instrumented, military carryalls of the same make, model, and year, and occupied by anthropometric dummies, show that the ratio of collapsible front-end structure to rigidity in the present, standard-size American automobile is such that the car is decelerated in a very short total deformation distance. Thus, there is insufficient time to permit the occupant's restraint within the car to be stretched to an appreciable load-bearing condition before the car body velocity approaches zero mph.

When driver dummies of different weights are used, the heavier dummy applied higher crash forces to the steering column, producing column collapse action and correspondingly diminished chest deceleration. At the same time, he may be impaled on the extended steering column shaft during his involuntary action of being crushed against it. A steering column should be designed to provide force moderation during collapse. Moreover, the steering wheel attached to this force-moderating shaft should be designed to distribute these forces uniformly to at least 80 sq in. of chest area.

To Order Paper No. 211D . . .
from which material for this article was drawn, see p. 6.

Powerplant Bending



Powerplant bending is the oscillatory bending or "beaming" of the structure formed by the engine block, clutch housing, transmission, and transmission-extension. All vehicles equipped with conventional Hotchkiss or torque tube drivelines are prone to this malady.

Bending occurs primarily in the vertical plane as shown. It may be difficult to conceive that this structure — which appears so rigid — could bend. But when these rigid structures vibrate at their resonant frequencies in the vicinity of 100 cps, amplitudes of vibration approaching a maximum value of 0.025 in. are attained.

This phenomenon hasn't caused structural fatigue problems, but it can produce one or more critical speeds at which the car is disagreeably noisy.

Greatest potential for structural changes is in the powerplant assembly and changes to the powerplant may strongly influence the response of the complete drivetrain. . . . So this paper concentrates on the structural group of the engine block, clutch housing, transmission, and transmission extension.

Noise caused by powerplant bending is a "period" type of noise. This refers to pure tone noise — due to a component resonance — which peaks at certain car speeds. Car speeds at which such pure tone noises occur are "period speeds."

Car Powerplant Can

Based on paper by

R. H. Bollinger and J. H. Ruhl

Ford Motor Co.

POWERPLANT BENDING NOISE, once it is properly identified, can be reduced by modifying one or more of the following:

- Vibration input
- Drivetrain structure
- Drivetrain mounting
- Body (or chassis)

Other factors remaining equal, it is generally better to alter the system than to attempt to reduce inputs. . . . This is true particularly when the system is responding to several inputs.

Usually, individual improvements will be additive. Thus, a sizable reduction of powerplant bending noise could be obtained by combining several lesser improvements.

Structural modifications

Drivetrain natural bending frequency generally is made as high as possible. Prime goal is a frequency high enough to keep the first order driveshaft unbalance frequency from exciting the drivetrain in the car's speed range.

Examination of the dynamic bending curve shows that certain drivetrain components, such as the engine, clutch, and transmission, have very small deflections over their lengths. Furthermore, the joints between these components act somewhat as hinges.

Thus, large increases in natural frequencies should be obtained by reducing or eliminating these joint deflections by such means as the gusset used to reinforce the clutch-housing-to-engine-block joint in Fig. 1.

Additional stiffening of individual structural components has little effect on increasing the powerplant bending natural frequency as long as no joint change is made.

Bending Noise

Be Reduced

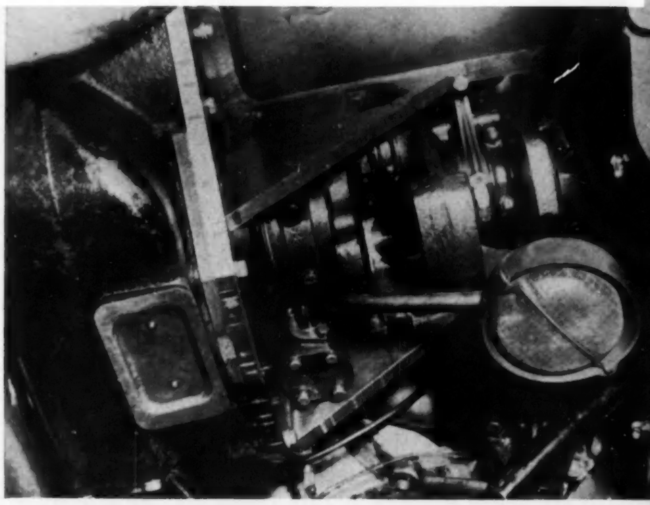


Fig. 1 — Experimental gusset to stiffen joint between clutch housing and engine block.

The following three basic design parameters should be part of future conventional power plant designs when an increased natural frequency is desired:

1. The slope of the structural bending curves should not change abruptly at the joints.

2. The structural material of the powerplant should be kept as far from the neutral axis and have as few changes as possible in load path direction.

3. Joints should be eliminated when possible by combining adjacent component housings.

In rare instances lowering the drivetrain natural bending frequency may be necessary to obtain the desired results. In this case the three design parameters should be ignored or their opposites applied.

Ford is currently incorporating these parameters into a combined clutch housing, transmission and transmission-extension structure to determine the miximum limitation for this concept. A mockup of this design is shown in Fig. 2.

Car chassis and bodies are also vibrating systems, responding to powerplant bending vibrations transmitted through the mounts and other connecting members. In some instances car bodies were found to be sensitive to powerplant bending vibrations. This extra sensitivity stems from body structure resonances which, because of their proximity to powerplant bending frequencies, reinforce the transmitted vibrations.

To reduce this sensitivity, it is necessary to modify the body. Increased rigidity may be achieved by adding new body structural members or strengthening existing members. The mount attachment areas are particularly sensitive. Moving the mount bracket to a different transverse location has on occasion produced measurable improvements.

Panel deadening may also provide slight help, but this treatment should be left as the final touch.

Excitation reduction

Output vibration magnitude can be reduced by reducing the input forces. The following discusses several typical inputs and (where possible) methods to reduce them.

Engine Unbalance (1st order engine) — The unbalance forces in inherently balanced engines can be reduced by improved quality control. This may mean modifying a balancing method, for example balancing the engine in the vertical plane instead of the horizontal plane. Inherently unbalanced engines may require counterweighted shafts or gear sets.

Torque Variation (½, 1st, 1½, 2nd, etc. order engine)—These torque variations are the result of

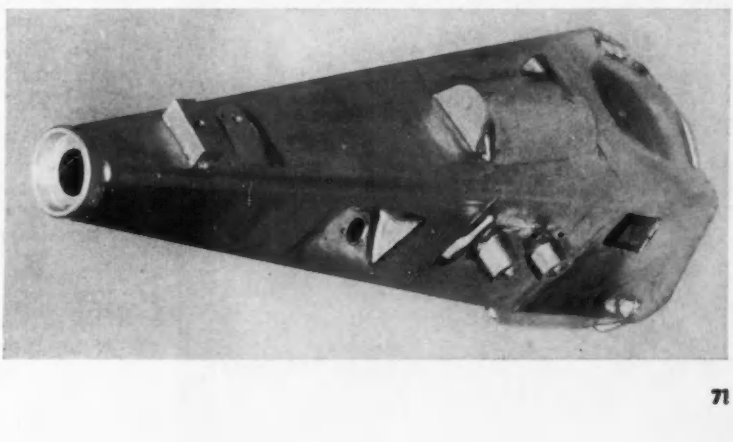


Fig. 2 — Experimental mockup of structurally-combined clutch housing, transmission, and transmission extension.

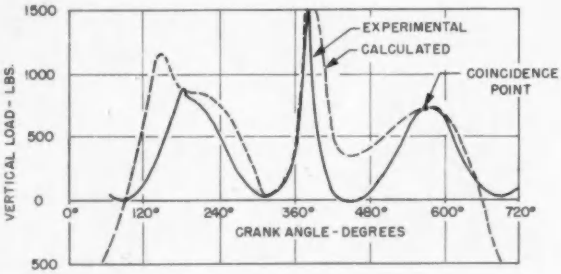


Fig. 3 — Rear main bearing impact loads.

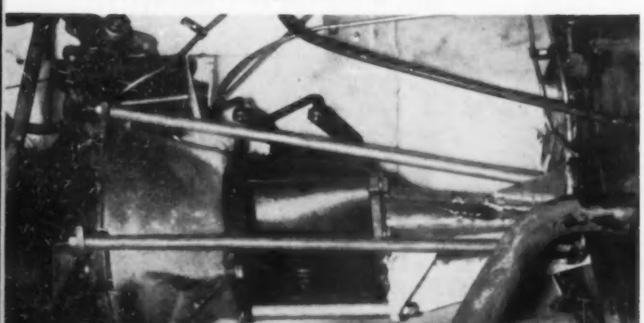
one or more cylinders firing more strongly or weakly than the average of all cylinders. Reduction is achieved by improved induction or ignition systems.

Engine Firing Impulses (4-cylinder — 2nd order engine, 6-cylinder — 3rd order engine, 8-cylinder — 4th order engine) — The mechanism of how these always-present vibratory forces cause the power plant to bend is not completely understood. Measurements of instantaneous bearing cap loads as shown by Fig. 3 have revealed that impact forces exceed 1500 lb. One hypothesis is that the shock waves generated from these impacts are transformed into structural bending, particularly when the impacts occur at the structure's natural bending frequency. A different hypothesis includes the flexibility of the crankshaft in bending as an important coupling of the firing impulses to structural bending. Some improvement may be obtained by decreasing the main bearing clearances and/or stiffening the crankshaft.

Driveshaft Unbalance (1st order driveshaft) — Whipspeed is strongly influenced by moments generated by internal unbalances which lie dormant until the speed is reached that the driveshaft no longer behaves as a rigid body. Nodal point balancing (locating the counterweights at the free-free bending nodes) will help avoid introducing these additional internal moments and reduce the tendency of the driveshaft to bow.

Universal Joints (2nd order driveshaft) — Bending inputs arising from universal joint side couples can be reduced by altering the angle of either the first or second joint behind the transmission-extension. It is the arrangement of the joint angles

Fig. 4 — Experimental reinforcement rods added to powerplant structures to increase bending natural frequency.



during high torque that is important to the forces generated, not the configuration with the car at rest. Improved joint angles may be determined experimentally or analytically. If these cannot be changed sufficiently, a carefully positioned snubber above the pinion nose may be necessary to provide joint angle control. Installation of a constant velocity universal joint at one or both ends will also reduce the universal joint couples.

Accessories — Inputs from accessories should be considered on an individual basis. There is no general approach except to assure that good design practice and quality control has been applied to items such as the generator, power steering pump, and air conditioning pump.

Isolation of powerplant bending vibration from the vehicle

At times it is impractical to eliminate the drivetrain exciting forces or modify the system to change the resonant bending frequency. Under these conditions it becomes necessary to isolate the vibration from the vehicle. Since engine mounts are the primary vibration paths from the drivetrain to the vehicle, they are usually the first component investigated.

Powerplant bending implies that at least two bending nodes exist on the powerplant. These nodes are points of relatively small amplitude and are, therefore, optimum transverse locations for engine mounts. Since it is not always possible to position the mounts directly in the transverse plane of the nodes (which are usually experimentally determined), they should be located as close as other factors will permit.

Another approach is to reduce the amplitude of the vibratory forces transmitted through the engine mount. Powerplant bending amplitude at resonance is a function of the input force and the internal system damping. Changes in the conventional engine mount dynamic spring rates will not appreciably change the bending amplitude. Thus, it is reasonable to conclude that reductions in spring mount rate for a given bending deflection will reduce the transmitted forces, since:

Transmitted force = Engine Displacement × Mount Dynamic Spring Rate (Approximately)

One limitation to both approaches is that the engine mounts must satisfy other conditions. The rates needed to reduce car shake do not always give sufficient isolation to bending vibrations.

Undoubtedly, there will be times when perfect engine mounts will not eliminate the objectionable power plant vibrations from reaching the passenger. In these cases, the vibration will enter the body by some other vibration path. It then becomes necessary to provide further isolation for these other paths between the drivetrain and body. Low rate spring connections may not be practical for rear spring and shock absorbers, and it may be necessary to use a sub-frame or increase the body mass at the attachment areas.

Specific cures for powerplant bending

Noise and vibration due to powerplant bending in

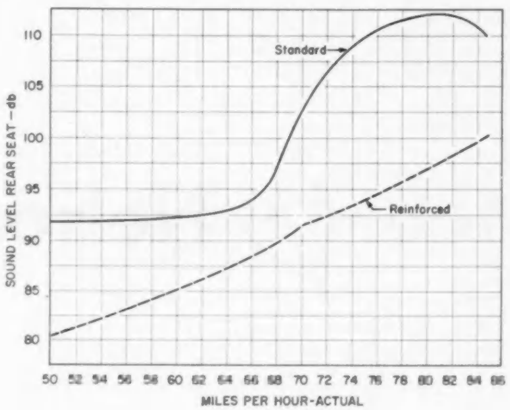


Fig. 5 — Noise reduction achieved by reinforcing powerplant.

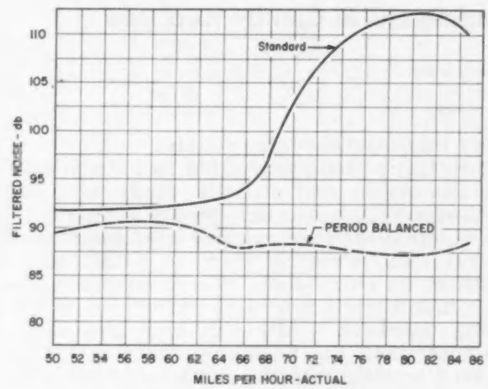


Fig. 6 — Noise reduction achieved by period balancing.

the 1949 Ford was eliminated by substituting a ferrous casting clutch housing for the stamped clutch housing. This change improved the car by accomplishing the following functions:

1. It increased the speed of the high speed (driveshaft unbalance) period above the driving range.
2. It moved the lower speed periods (firing impulses and universal joints) away from critical body resonances.
3. It reduced the amplitude of bending.
4. It moved the node closer to the mount position.

Power plant bending was later encountered on one of the first unitized constructed vehicles. Prototype models of this car were found to have several severe noise periods ranging 600–1100 engine rpm. An additional period occurred on the road at the speed of 60–70 mph. Investigation revealed that the lower speed periods were the result of several of the accessories exciting powerplant bending. The 60–70 mph period was also powerplant bending excited by second order driveshaft.

Thus, it was decided to work on the system rather than the individual inputs. The response of the system was detuned by the addition of a dynamic absorber tuned to the frequency of the drivetrain (60 cps). This produced a marked improvement in the passenger compartment noise without introducing additional noise peaks at other speeds.

In a recent prototype, powerplant bending was found to cause an objectionable interior noise at 80 mph. This was traced to drivetrain bending, excited by unbalances of both the crankshaft and driveshaft.

Since the period occurred just below the top speed one suggestion was to increase the powerplant rigidity, increasing the resonant frequency so that the period would occur above the speed range. To simulate this rigidity, the reinforcing structure shown by Fig. 4 was superimposed on the production powerplant. This raised the critical speed from 80–93 mph. Fig. 5 compares the interior sound level versus miles per hour. Although this approach was successful it was too close to production time to incorporate the needed changes; so further meth-

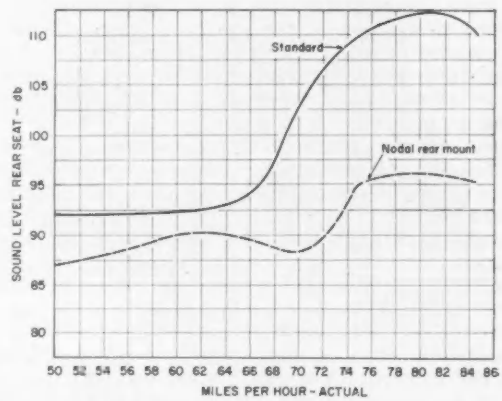


Fig. 7 — Noise reduction achieved by nodal mount.

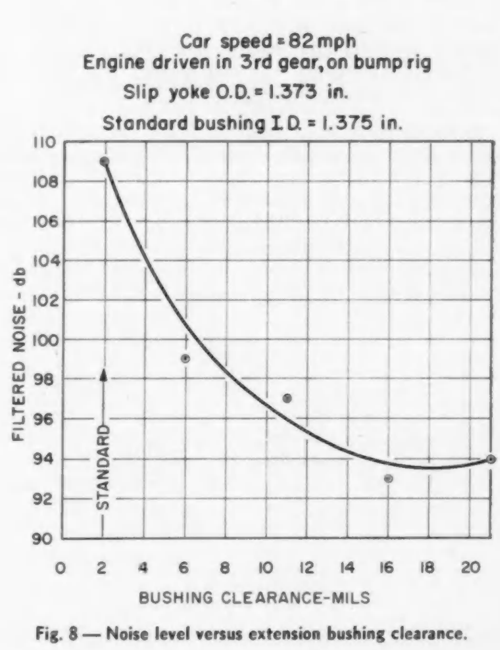


Fig. 8 — Noise level versus extension bushing clearance.

Bending Noise Can Be Reduced

. . . continued

ods of improvement were sought.

Since this period was excited by unbalances from both the engine and propeller shaft, both components were balanced at the speed of the period. This was accomplished by running the components in the car and balancing them to within less than 1/10th of an ounce-inch. Fig. 6 compares the interior sound levels before and after the period balancing operation. Although this treatment was also successful, the balancing speed and accuracy required to eliminate the noise were not practical for production.

An experimental rear engine mount and bracket located at the nodal point was designed and installed. The noise reduction results, shown by Fig. 7, were highly encouraging. This experimental mount design was later modified slightly and incorporated into the final production design.

An interesting phenomenon encountered during these tests was the effect on the period of an oversized transmission-extension bearing. A small increase in the bearing clearance apparently permitted the propeller shaft to revolve with a slight eccentricity without disturbing the powerplant.

Subsequent tests with this discovery showed that the interior noise level decreased with increasing bearing clearance as shown by Fig. 8. In combination with the nodal mount described earlier, a 0.0001-in. oversized extension bearing virtually removed all trace of the high speed vibration (Fig. 9).

A specific case of body structure revision affecting the powerplant bending noise was also encountered on this same car. Road tests indicated that floor panels were contributing to the high speed noise peak so that floor reinforcing rails, which originally terminated at the front seat, were extended to the rear axle kickup. These reinforcing members (which decreased the span of the rear floor panels by about ½) decreased the total rear seat noise by several decibels.

To Order Paper No. 203A . . .
from which material for this article was drawn, see p. 6.

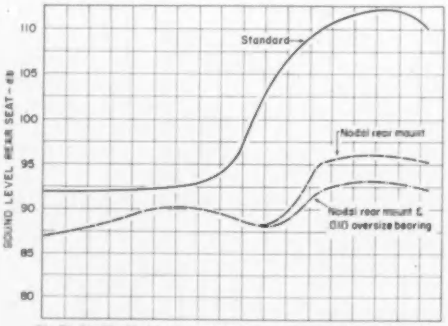


Fig. 9 — Noise reduction achieved by oversized extension bushing.

Nelson

Abridgement of an

SAE Northern California Section talk by

Theodore Nelson
Nelson Specialties

THE NELSON 2-stroke, helicopter engine (Fig. 1), which has successfully passed the FAA certification test, employs several unusual features to meet the basic requirements of aircooling, light weight, small size, and high horsepower output with extreme reliability.

To get adequate cooling

The first major problem — to get the necessary cooling without penalizing horsepower heavily — was solved by using a fiberglas shroud to direct and enclose the cooling air, coupled with a formed aluminum fan. This reduced horsepower requirements to a little less than 1.5 from an earlier 3-4 hp.

Dissipation of heat from the piston head is aided by using a vented piston, which simply forces a small amount of the crankcase compressed fuel mixture (gasoline and oil with air) through a port in the side of the piston and then into the intake bypass as it gets to the combustion chamber. This results in a drop in piston temperature of about 100 deg.

Use of temperature sensitive paints showed the center of the piston head reaching a maximum temperature of about 500 F and the skirt about 250 F. To provide for this uneven heating, the pistons are machined with a 0.007-in. taper. Piston pin needle bearings operate in the piston bosses at about 300 F with no ill effects.

Crankcase compression seal

Probably the most unique feature of the engine is a rotary valve on the crankshaft to control the fuel mixture through the crankcase. There are two valve plates made of a very light molded plastic.

H63-C Helicopter Engine

These are inserted on to the crankshaft and on each side of the center bearing housing which forms part of the intake system. The plates are rotated by two driving dogs each and held against the face of the center bearing by light leaf springs. This valve gives a positive seal at all times during crankcase compression, allowing for manufacturing tolerances and expansion differences.

A two-stroke engine

An aircooled, 2-stroke engine requires a richer mixture at reduced power setting than at full power, therefore a conventional carburetor will not suffice without some type of variable metering system. The Nelson engine, for example, uses 6.2 gph at full power and 6.5 gph at around 85% power. This is necessary to get a satisfactory reduction in cylinder head temperatures with a reduction in power. The carburetor has diaphragm fuel control with a metering groove in the fuel chamber, which changes in size with throttle positions. By the size and shape of the groove, the fuel/air ratio mixture can be controlled at any throttle or power setting. This is considered to be one of the major reasons for the success of the engine in passing the FAA certification test.

Construction details

The crankcase is a 2-piece, magnesium alloy casting, divided horizontally. This design eliminates through-bolt construction and makes assembly easy. The cylinders are diecast aluminum alloy 380 with chrome-plated bore and integral head. Cylinder liners are plated with hard chrome and ground after plating. Since fuel is admitted on both top and bottom sides of the pistons and rings in a 2-stroke engine, it was reasoned that the wetting qualities of porous chrome were unnecessary and this has been borne out by test.

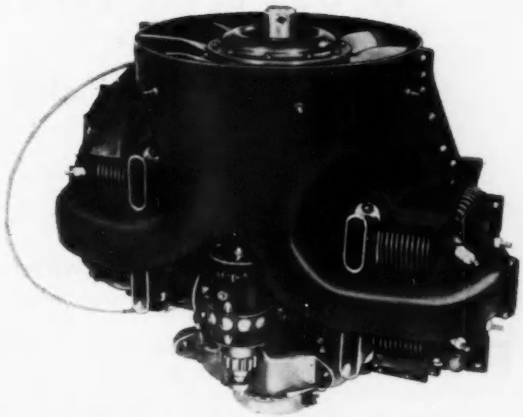


Fig. 1 — Nelson H63-C, 2-stroke, helicopter engine. Fiberglas shroud and aluminum fan visible on top, combine to give satisfactory cooling with low horsepower consumption.

The crankshaft is made of nitralloy steel A-132 and all bearing surfaces are nitrided. The rough forging is heat-treated to about 28–32 RC hardness and machined in that condition. After rough machining, the shaft is copper plated and the areas not nitrided are then rough ground to fairly close tolerances. The copper-free areas are then nitrided and the shaft is finish ground to precision dimensions. This procedure practically eliminates loss of shafts from heat-treat distortion. The steel gives a minimum weight design with maximum tensile strength of about 135,000 psi, and excellent fatigue life and wear resistant bearing surfaces.

H63-C Specifications

Rating at 4000 rpm, hp	43
Bore and Stroke, in.	2 11/16 × 2 3/4
Displacement, cu in.	63
Total Weight, lb	76

Satellite costs slashed

▶ First stage air breathing boosters get their oxidizer free for 63% of the fuel a rocket would use. Recoverability also spreads costs over many missions.

Based on paper by

W. H. Bond and R. F. Mawhinney

Convair — San Diego, Division of General Dynamics Corp.

"THE operating cost of an expendable all-rocket system can possibly be cut in half by using an air breathing booster" is the conclusing drawn by Convair-San Diego after completing an economic feasibility study. The study is for 500 launchings over a five-year period. The results are shown in Fig. 1 for three different types of air breathing engines designed to different states-of-the-art.

The two main reasons for this economy are the ability to reuse the air breathing booster and the efficiencies possible by *using* the atmosphere rather than getting through it as soon as possible.

The cost trends for a two-stage vehicle are shown in Fig. 2 as a function of recoverability of the first stage. The second stage is always expendable. This shows the strong influence of recovery on costs and at the same time points out another trend. As the separation velocity increases, the costs drop rapidly. This drop is further emphasized if the recoverability is high.

The straight rocket booster will spend up to 63% of its fuel just to get beyond the sensible upper limits of the atmosphere — about 100,000 ft. The heating value of the fuel so used can be reduced by a factor of 5–8 when the weight of the oxidizer is included. It is this high oxidizer factor that makes air breathing boosters look so tempting, especially as studies accumulate that justify air breathing engines for higher speed applications. For instance, the thrust coefficient can be substantially increased for an air breathing engine by placing the inlet behind the oblique shock wave formed by the wing. This allows the engine to capture more air and also acts as a first compression stage for the engine. This effect increases with angle of attack.

The advantage of using an air breathing engine in a lifting vehicle are:

1. Returning from space, a lifting recovery into the atmosphere can be made.

2. A lifting vehicle has the ability to return to base in case of malfunction.

3. Existing airport facilities can be used.

4. Manned flights are easier to achieve because accelerations are about 1*g* and flight path angles are low.

5. The orbit plane can be choosen while the booster is still in the atmosphere.

6. Other missions can be performed such as ferry, bomber, transport, and boost glide.

The problems involved in achieving an air breathing booster design include, first of all, the research and development cost. The magnitude of this cost is highly controversial. However, it is probably higher than that for a rocket booster. This detracts from the lower operating costs of the air breathing booster.

Because it remains relatively low in the atmosphere, the air breathing booster will experience high air loads and temperatures. This will complicate the design of the vehicle and its components.

Staging will be more complicated because of the high air loads and the configuration needed to get aerodynamic balance. Fig. 3 shows some of the flight limits on a speed-altitude plot.

This article is based on a presentation at the SAE National Aeronautic Meeting. Although the presentation was classified, a written version was declassified and is now available as Paper No. 177B. . . .

To order Paper No. 177B . . .
from which material for this article was drawn, see p. 6.

by air breathing boosters

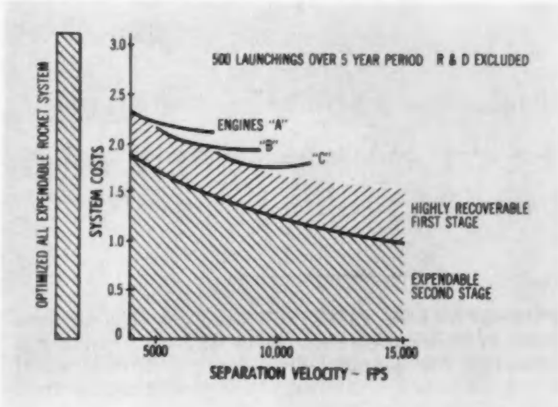


Fig. 1 — **ALMOST A TWO TO ONE COST REDUCTION** is possible using an air breathing booster as the first stage of an orbital vehicle.

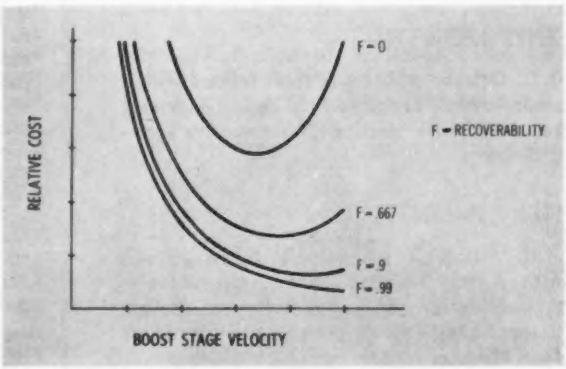


Fig. 2 — **RECOVERABILITY** is a major item in cost reduction of a two-stage orbital vehicle. High recoverability also permits economical operation at high separation velocities.

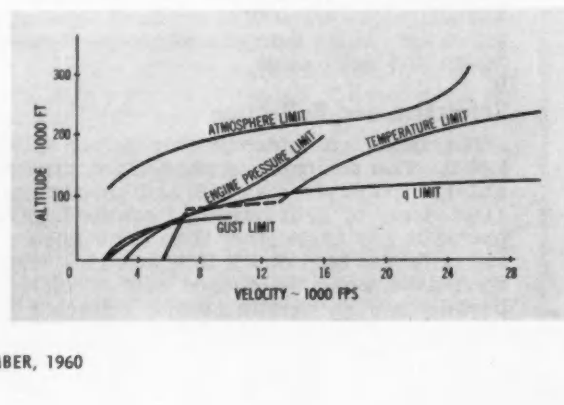


Fig. 3 — **FLIGHT LIMITS OF THE AIR BREATHING BOOSTER** include: dynamic pressure, **q**, because of the aeroelastic properties of the structure; gust loads reflect the strength of structure, especially the wings; bursting pressure of the engines; boundary layer temperature generated in the atmosphere; and an atmospheric limit above which there would be too little air to support engine operation and wing lift.

designing with plastics

Optical Unique Effects

Based on report by

R. C. Oglesby
Rohm & Haas Co., Inc.

LAST MONTH—

du Pont's J. H. Crate and J. D. Young launched SAE Journal's current 6-article series on "Designing with Plastics for Automotive Applications." (See p. 33, August issue)

THIS MONTH—

R. C. Oglesby of Rohm & Haas follows with a second article aimed to help design engineers concerned with plastics for automotive applications.

NEXT MONTH—

J. H. Versteeg is scheduled to follow-through with Article Number Three. He writes — especially for SAE Journal — on Hollow Shapes and Thermoformed Articles Made from Plastics.

IN THE FOLLOWING MONTHS—

This exclusive SAE Journal series will be completed with articles by:

- A. J. Carter of Chrysler on Strength and Stiffness Properties of Plastics
- J. R. Forrester of Ford on Plastics Applications Involving Color and Texture
- P. Weiss of General Motors on Foamed Plastics and Flexible Materials

ALL SIX ARTICLES will be available early in 1961 as SP-184 at $1.50 to SAE members; at $3.00 to nonmembers. To place your order now, see p. 6.

TRANSPARENT PLASTICS are receiving increasing consideration as optical and decorative materials by the automotive industry. Proper application of plastics, however, requires careful study of part design and function as well as a thorough knowledge of the properties and potentials of the various plastics. For optical applications, optical function, refraction and reflection, lighting techniques, and the shape of the part are among the important considerations. Intaglio, embossed and raised relief, sculptural three-dimensional effects, surface textures, integrally colored parts, surface painting, and vacuum metalizing are some of the decorative treatments which require searching study.

Optical Functions

Accurate, light-weight, well-appointed automotive optical components can be created by the automotive designer by using acrylic plastic as a medium for instrument panel controls, parking, tail, and backup light lenses, medallions, and such.

The determining factor in the successful use of acrylic plastic for optical functions is the careful application of simple optical principles. To the designer, optical principles of the greatest importance are those derived from the natural laws of refraction and internal reflection. This is especially true of plastic parts that are designed to be illuminated by natural or artificial light. Proper use of light is the core and substance of successful design and application.

Refraction and Reflection

The index of refraction for acrylic plastic is 1.4890. This compares to glass which ranges from 1.52–1.89, polystyrene at 1.58, and air or vacuum at 1.00. A ray of light passing from air into acrylic plastic at any angle other than perpendicular with the surface is bent at the interface (the surface of the plastic which is touched only by air). Light passing into an acrylic part is refracted toward

Techniques Create in Transparent Plastics

Using the laws of refraction and reflection with proper control of light, designers are finding more and more uses for acrylic plastics as optical and decorative parts in the automobile.

the normal or perpendicular. Light leaving the acrylic is refracted away from the normal (Fig. 1). The angle between the incident ray and the normal is the "angle of incidence". The angle between the refracted ray and the normal is the "angle of refraction". These angles are always measured between the rays and the normal — not between the rays and the plane of the interface.

If a light ray strikes an acrylic surface at the normal angle, 96% of the light passes through the acrylic and continues in a straight course. There is virtually no loss of light by absorption in nominal thicknesses. Approximately 92% of the light will emerge from the opposite surface. Four per cent is lost through scattering at each interface (Fig. 2). As the angle of incidence is increased, the amount of light lost at the first interface by reflection will also increase. However, this reflection loss does not exceed 10% until the incident angle exceeds 60 deg (Fig. 3).

A ray of light within the acrylic plastic, striking an air interface at an incident angle of 42.2 deg or more will not pass through the interface. It will be totally reflected from the interface at an equal and opposite angle. In other words, the critical angle for acrylic plastic is 42.2 deg. Many functional light control problems can be solved by using this critical angle as a basis for design. For example:

When light enters a square cut edge and the main surfaces of the acrylic part are parallel, the internally reflected light rays will be reflected back and forth from one surface to another until they strike a surface with an incident angle of less than 42.2 deg, where they will escape. This principle has been successfully applied to produce a halo effect around a speedometer pointer, or similar instrument panel control components.

Lighting Techniques

Acrylic plastic parts can be edge lighted, back lighted, flood lighted, or illuminated by "piping" the light through the part. Light piping is usually reserved for solving problems of transmitting light around bends in acrylic rods, bars, or curved plates. To efficiently transmit internal light in this way, within a curved acrylic piece, the minimum inside radius must be at least twice the thickness of the part. If this is not recognized as a design criterion, many rays of light will be lost through the outer surfaces because they strike it at less than 42 deg from the normal. Stray rays from light piping applications often exist with an adequate inside radius. Here, the amount of light lost is minor, but appropriate masking must often be applied to

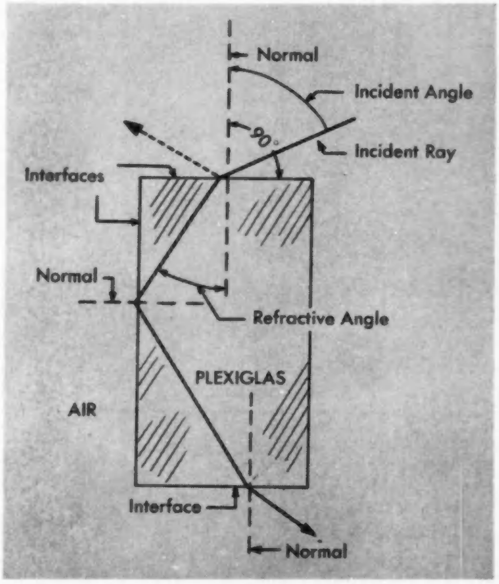


Fig. 1 — Light passing into an acrylic part is refracted toward the normal or perpendicular. Light leaving the acrylic is refracted away from the normal.

prevent the stray light rays from creating a distracting appearance. Suitable bezels are usually employed for this purpose.

Edge lighting is perhaps the most common technique applied to acrylic parts. In edge lighting, it's important to clearly establish the light-entry conditions, control of light within the part, shape of the part in relation to the light source, and the design of the lettering or decoration to be illuminated. As a rule, the light source should be located as close to the edge of the part as possible to insure entry of as much light as possible. Consideration should be given however, to the thermal conditions caused by the lamps. Fluorescent or glow lamps generate very little heat, and, consequently, can be placed extremely close to the acrylic part. Incandescent lamps should be placed 1/16–½ in. away from the part depending on lamp wattage. A 15 w lamp should be placed no closer to an acrylic edge than 1/16 in. This dimension is also variable in relation to ambient temperature.

Reflectors placed behind the lamps are effective in increasing the available light at the edge of the part. When used, reflectors with a satin finish or a flat-white opaque finish perform most satisfactorily.

Control of edge lighting must be carefully considered to obtain optimum effect and to reduce stray rays and offensive glare. As previously stated, a ray of light striking an acrylic part at the normal angle will enter the part with about 96% efficiency. To redirect the light at predetermined points within the part so that the desired effect can be obtained requires careful lighting control. Internal light control is usually exercised by varying the surface contour of the acrylic part, selecting suitable surface finishes and textures, coating with light or dark paint, and covering or spotting with metallic deposits. Employing any or all of these techniques enables the designer to direct and redirect the light rays to produce desired effects and images.

Frosting, sand blasting, honing, or scratching the polished reflective surfaces of an acrylic part will cause the rays to scatter as they strike the locally abraded area. Edge lighted markings should be on the back (second surface) of an acrylic part because the rays reflect back from the abraded zone and emerge to create the image seen through the front surface of the part. A few rays penetrate the abraded area and appear as a glow at the second surface.

Embossing, debossing, etching, and faceting are other common techniques used to control internal lighting. When the rays strike these markings, they are reflected as true images at the first surface of the part. Frosting or paint filling of the markings improve visibility of markings when unlighted, and enhance the appearance generally.

The shape of the part plays a very important role in the control of internal light. Curved light leads are more efficient than angular ones. However, curved leads require more lateral space, which may pose problems where edge space behind a dial is limited. In unusually tight areas, a 45 deg angle may be employed. (Figs. 4 & 5). By using a polished facet perpendicular to the bisector of the angle, light can be conducted around corners of 90 deg or more. It is possible to coat the polished

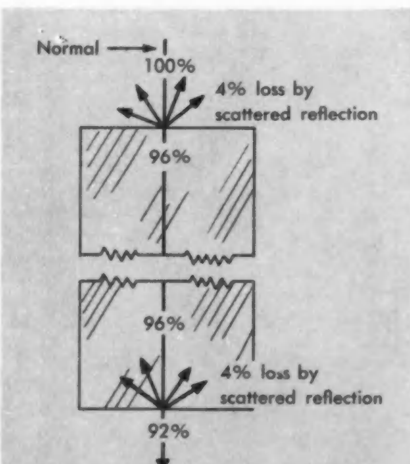


Fig. 2 — If a light ray strikes an acrylic surface at the normal angle, approximately 92% of the light will emerge from the opposite surface. Four per cent is lost through scattering at each interface.

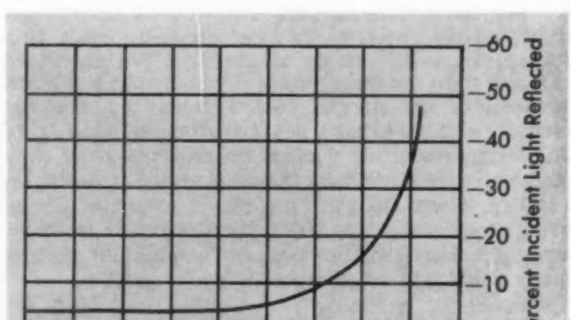


Fig. 3 — As the angle of incidence is increased, the amount of light lost at the first interface by reflection will also increase. However, this reflection loss does not exceed 10% until the incident angle exceeds 60 deg.

Richard C. Oglesby has been actively engaged in all phases of plastic design and production since joining the Rohm & Haas Company in 1941. A graduate of the University of Rochester with a B.S. in Chemical Engineering, Oglesby's first assignment with Rohm & Haas was at the company's Bristol, Pennsylvania plant where he worked in product development and production of acrylic resins.

During World War II he was assigned to Rohm & Haas' Southgate, California plant as Chief Engineer and later, Plant Superintendent with activities devoted to the manufacture of aircraft components made of Plexiglas, such as gun turrets, canopies, bomber noses, with the responsibility for transferring aircraft requirements for aerodynamic shapes into production parts made of cast acrylic plastic.

For the past 13 years, Oglesby has been with Rohm & Haas' Detroit office. In 1955, he became the District Manager for that office. His activities in this capacity are centered around sales and sales development work — a great deal of which has been with the various automotive design groups. Oglesby's contribution to the SAE Journal stems from long, first-hand experience in the plastic field.

Oglesby

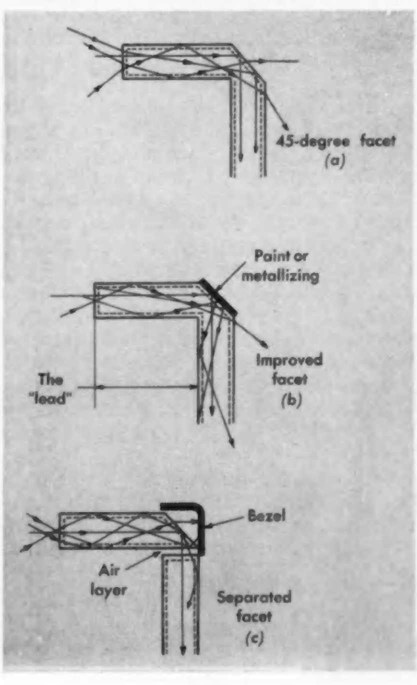
facet with white paint to minimize the loss of light through the reflecting facet. A light loss condition at this facet is evident because the light from an edge source is seldom parallel to the principal surfaces. Metalizing and hot stamping is more efficient for this purpose, but is warranted only when design parameters preclude cost economies. Frosting is seldom effective.

Vertically mounted rectangular parts, like speedometer or radio dials, are best lighted from the top edge. White paint applied to the opposite edge, particularly near the ends, will improve the lighting effect.

Cylindrical or elliptical parts can be effectively lighted by placing an integral funnel load of acrylic off from one quadrant of the dial, and painting the edge of the opposite side white through at least half the circle. Undesirable shadows can often be eliminated by white painting within a center hole and around the dial edge.

Back lighting is ordinarily used in illuminating large panels, particularly when they must be clearly visible under high ambient light conditions. Fluorescent lamps, although not yet adapted to automotive functions, are excellent for this purpose, as they offer more useful light with less heat

Fig. 4 — In unusually tight areas, a 45 deg angle is used to control internal light. Painting or metalizing the facet provides less loss of light. Using a bezel provides a still more efficient system.



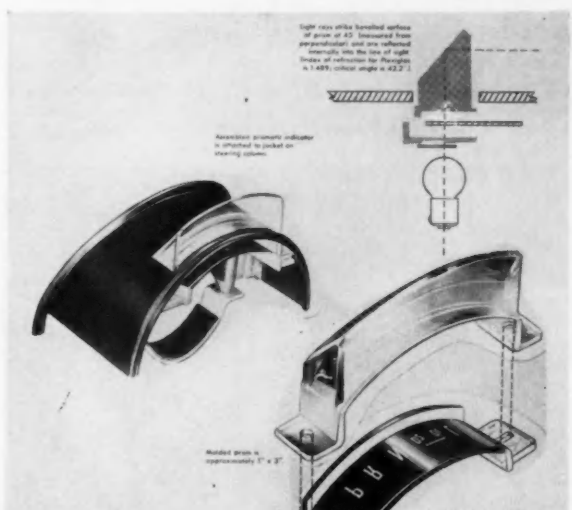


Fig. 5 — Prismatic indicator with light rays striking bevelled surface of prism at 45 deg

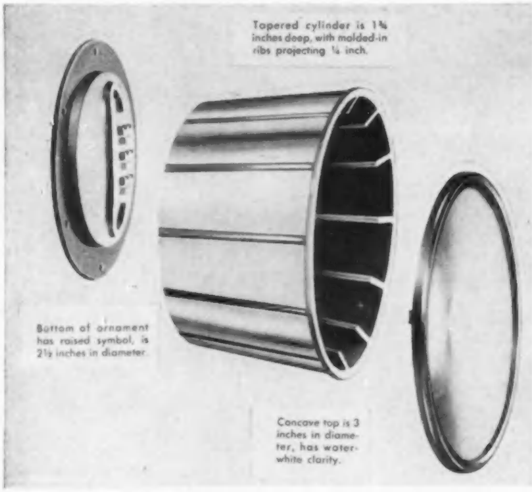


Fig. 6 — Decorative treatments such as intaglio, embossed and raised relief, sculptural three-dimensional effects, surface textures, integrally colored parts, surface painting, and vacuum metalizing can be applied either individually or in combinations to obtain attractive, unusual results.

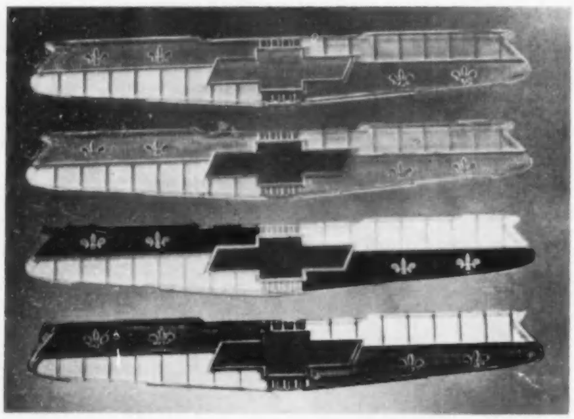


Fig. 7 — Recessed and raised letters are a common decorative technique applied to acrylic plastic parts. Recessed areas can be paint filled or textured, or they can be patterned to produce exciting effects.

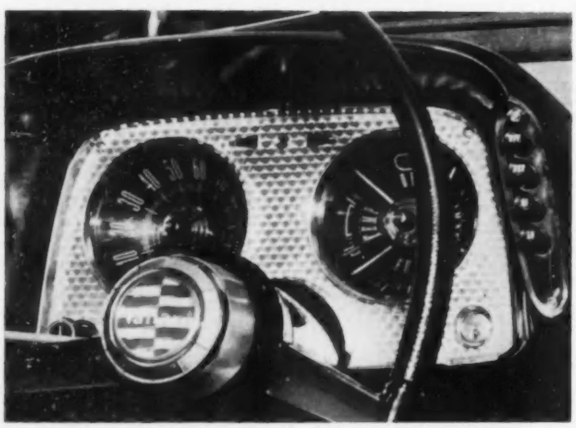


Fig. 8 — One-piece clear Plexiglas molding covers instrument dials of Valiant. Vacuum metalizing produces fascinating effect on the first surface of the molding.

Transparent Plastics

. . . continued

than ordinary filament bulbs.

While many unusual and decorative effects can be achieved through lighting alone, acrylic plastic lends itself well to more orthodox decorative treatments. Such treatments include intaglio, embossed and raised relief, sculptural three-dimensional effects, surface textures, integrally colored parts, surface painting, and vacuum metalizing. These techniques can be applied either individually or in combinations to obtain attractive, unusual results. (Fig. 6).

Most acrylic decorated parts such as escutcheon plates and horn buttons are intaglio molded from colorless plastic. By having the detail of the design on the second surface, brilliant three-dimensional effects are created. Color coatings applied to the second surface are permanently protected from dirt and damage. A translucent appearance can be obtained by frosting the intaglio design in colorless or tinted acrylic.

Sculptural moldings of acrylic plastic produce unusually beautiful ornamentation. Such parts afford the opportunity to use ambient light — either artificial or natural — to full advantage. Hood ornaments on several automobiles are made of acrylic moldings and are both pleasing to the eye and highly practical from a service and durability viewpoint. Since acrylic plastic causes very slight mold wear, a single precision mold can produce virtually an unlimited number of identical parts.

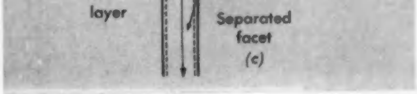
Recessed and raised letters are a common decorative technique applied to acrylic plastic parts. Recessed areas can be paint filled or textured, or they can be patterned to produce exciting effects (Fig. 7). Raised letters permit low cost hot stamping techniques to be used.

Colors for acrylic plastic parts can be applied or integral. A wide selection of transparent, translucent, and opaque colors are available in standard molding powders. Special colors can also be developed to suit particular applications. Combinations of tints and colors can give unusual and distinctive effects.

Colors can be applied to acrylic plasic parts by spray painting, silk screening, hot stamping, wipe-in-painting, and rolling. Spray painting is usually done to the second surfaces of molded three-dimensional trademarks, nameplates, and escutcheons. Application of several different colors necessitates the use of carefully prepared metal masks.

Recent improvements in hot stamping have resulted in an accurate method of applying numbers, letters, names, and such to reasonably flat surfaces. Colors such as gold and silver can be hot stamped with good results. Simple recessed areas can also be decorated by hot stamping, by designing a stamp to match the shape of the area and providing a border "moat" to eliminate registration problems as well as difficult corners.

Wipe-in-painting can be successfully used as a method of filling recessed letters or designs. Generally, paint is applied by spraying and excess paint is wiped clean from the background areas. Rolling



is usually reserved to apply paint to raised surfaces and symbols of an acrylic part.

Vacuum metalizing produces fascinating effects on the first and second surfaces of acrylic components. On first surface metalizing, a protective coating is recommended to assure durability. Second surface metalizing provides excellent weatherability. Through effective application of the vacuum metalizing technique, substantial cost savings can be obtained by integration of components — one-piece moldings formerly made of many parts. Recent design-production techniques have expanded in this area to include one-piece instrument clusters. (Figs. 8 & 9.)

Caution Signs

As with any material, there are specific physical characteristics which can pose problems to the design engineer who does not compensate for them either in the design stage, during production, or in the end-use of the finished product. With acrylic plastic, the question of thermal expansion should be thoroughly resolved during the design stage. In most cases the coefficient of thermal expansion for acrylic plastic will exceed that of any metals which may be used for the same purpose. To compensate for this higher coefficient of thermal expansion, elongated mounting holes and elastomeric grommets may be used when mounting the finished piece. Similar solutions for specific applications must be provided to prevent the acrylic part from developing fractures as the part is subjected to extremes of ambient temperature in confined areas.

Acrylic plastic is sensitive to notching. Sharp inside corners, especially around the periphery of the finished piece, often lead to elongated or "travelling" cracks when the piece is exposed to impact or torque loads. It's imperative that conditions conducive to notching be eliminated during the design and production stages of acrylic part manufacture.

Projected Uses

Plastics in general, and acrylic plastics in particular, have opened a whole new field for the design engineer. Currently, extensive research and experimental work is being performed to develop acrylic sheets surfaced with glass of high optical quality. The goal behind this project is to provide a suitable light-weight product for automotive use.

The use of acrylic emulsions as backing for exotic automotive upholstery is also enjoying expanded popularity. Modern trim fabrics often lack the "body" present in the heavy, less glamorous, natural fabrics. A backing of acrylic compensates for this lack of natural body and gives the designer increased latitude in creating exciting automotive fabrics.

In addition to its use as a fabric backing, acrylic resin is also used as a top coating for leather upholstery. Decorative top coats are becoming more important as more leather-type materials are being used for upholstery purposes.

In the past few years, acrylic resins have become increasingly popular as automotive body finishes, providing lasting beauty and improved durability.

The present usefulness and future promise of acrylic plastic provides today's automotive design engineer with almost unlimited potential.

TRANSPARENT PLASTICS have kept pace with the steady growth in the use of plastics by the U. S. automotive industry. As pointed out in the first article of this series (Designing with Plastics for Automotive Applications, SAE Journal, August 1960, pp. 33-37), the estimated use of plastics in the average 1954 automobile was about 10 lb. By 1959, this had grown to about 25 lb per car. Conservative industry estimates predict this figure will reach 50-80 lb or more by 1970.

In this general growth pattern, the transparent plastics are playing an increasingly important role, particularly in the areas of optical and decorative functions. For the automotive designer who wishes to incorporate the elements of beauty, weatherability, accuracy, and low-cost production of decorative automotive components, few materials match the versatility and scope of transparent plastics.

There are a number of plastics that fit into the "transparent" category: PVB safety glass interlayer, cellulosics, vinyl and polyester decorative films, to mention a few. However, most generally used for purposes of optical and decorative functions is the acrylic plastic. Through inherent properties, acrylic plastic is highly weather resistant, maintains dimensional stability, is breakage resistant, possesses exceptional clarity and transparency, provides precise molding accuracy, lends itself to many types of decoration — including vacuum metalized coatings — and can be machined, drilled, threaded, or routed with accuracy and little difficulty.

This article discusses the design of optical and decorative parts using transparent plastics. Case histories illustrate important design factors.

Recognizing the increased interest in plastics as engineering materials, the Plastics Subcommittee of the Engineering Materials Activity of the Society of Automotive Engineers, in cooperation with the Professional Activities Group on Plastics in the Automotive Industry of the Society of Plastics Engineers, is sponsoring this series of articles on plastics in the SAE Journal.

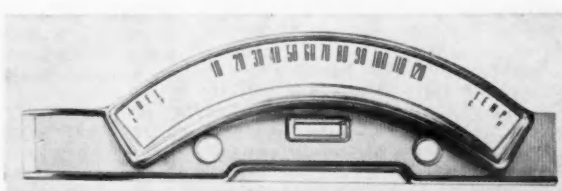


Fig. 9 — One-piece instrument cluster made possible by recent design-production techniques with acrylics.

BRAKE STANDARDS proposed by international group

CHARLES W. JACKMAN, an SAE member since 1922, is a member of the Working Party on Construction Vehicles which is in the process of working out proposals for international braking standards. Brakes have been considered in several meetings, including one in March and another in June, 1960.

The Working Party, whose membership includes administrators and engineers from all interested European countries, is acting under the Subcommittee on Road Transport of the Inland Transport Committee of the United Nations' Economic Commission for Europe.

Since these proposals are still under consideration, no conclusions can be published.

In the following paragraphs, however, Jackman — who is assistant staff engineer in charge of brakes, axles, and some other components at Chevrolet — summarizes the latest Working Party recommendations:

Definitions of Braking Terms. Definitions of the service brake function, emergency brake function, and parking brake function are included. These terms are to be studied by the International Standards Organization for adoption.

Classification of Vehicles Into Weight Categories. Vehicles are divided into various weight categories of passenger carrying and goods carrying types. Trailers are treated as individual vehicles in the brake performance requirements.

Requirements For Brake Performance. For each category of vehicles, stopping distances and test speeds are specified. Emergency brake performance requirements of at least one-half that required for service brakes are suggested. Two circuit brakes or equivalent are proposed for heavy trucks and buses.

Fade Tests. There has been much disagreement on this subject. However, it appears that one or more types of nominal grade descent requirement will be finally adopted. Equivalent level road tests may be used. Decelerators, such as exhaust brakes, are widely used in mountainous regions of Europe, and will probably be required on certain trucks and buses which are to operate in these areas.

Lag Time Or Airflow Time Tests. Such tests have been developed and are offered for approval.

Brake Fluid. The International Standards Organization probably will adopt brake fluid standards similar to those of the SAE.

Proposals adopted by the Working Party on Construction of Vehicles will require ratification by their parent committees of the ECE. These proposals will be recommended to the various governments for voluntary compliance and ratification. Obviously, much remains to be done. Upon adoption by the member countries of the ECE, these regulations can be applied for:

1. Model approval of vehicles in their countries of origin.
2. Tests for vehicles when first licensed.
3. Periodic safety checks.
4. Spot checks of vehicles in traffic.

Performance requirements as applied to items 3 and 4 above are somewhat less exacting than those for new vehicles. Because of existing differences in testing methods in the various countries, tests applied for determining conformance with these regulations will, in many cases, have to be developed to suit the practices and facilities of individual countries.

To Order Paper No. 184C . . . from which material for this article was drawn, see p. 6.

You Can Save By Cold Extruding

Based on report by secretary

R. W. PERRY
Parker Rust Proof Co.

COLD EXTRUSION has definitely established itself as a process offering such substantial savings that industry cannot afford to overlook it in connection with their future plans.

There are many advantages offered by cold extrusion with the most outstanding being that of material savings. When cold extrusion replaces a hot forging, stock allowances for scaling, decarburization, and die wear are reduced or eliminated. An even greater potential for material savings exists when replacing a screw machine part, as evidenced by the volume of chips daily produced in machine shops.

A second substantial advantage offered by cold extrusion is that it permits the use of lower cost steel, such as hot rolled rod rather than the cold drawn steel required by screw machines.

Cold extrusions can be maintained to very close dimensional tolerances, thereby reducing machining requirements. As costly automatic screw machines are replaced, facilities investment is reduced and cutting tool costs are lowered.

A fourth major advantage is improved physical properties. Improved grain flow that conforms to the shape of the part improves fatigue strength. Improved physical properties obtained through cold work may eliminate heat-treat operations. The fine finish of a cold extruded part eliminates tool marks and reduces the need for grinding.

All of these advantages are well illustrated by cold extrusion jobs currently in production.

Since 1955, Ford has extruded 40 million automotive piston pins. This has resulted in a savings of 5000 tons of steel. The fatigue life of the cold extruded pins averages 51,000 cycles versus 16,000 cycles for the former drilled pins.

In the case of a typical stop light switch housing for automobiles, cold extrusion has resulted in a material savings of about 80% over screw machine manufacture. Furthermore, cold extrusion has allowed the use of hot rolled rod for the manufacture of this part rather than the special quality cold drawn hexagonal bar stock required for screw machines.

A cold extruded tractor power takeoff shaft with improved physical properties developed by the cold forming operation has completely eliminated the heat treatment previously required.

Serving on the panel Futures in Cold Extrusion, upon which this article is based, in addition to the panel secretary, were: chairman, **J. F. Leland**, Parker Rust Proof Co.; **Larry Shiller**, Norris-Thermador Corp.; **Alfred Braun**, Braun Engineering Corp.; **D. J. Davis**, Ford Motor Co.; and **G. E. Groener**, General Motors Corp.

(This article is based on a report of one of 11 panels on production subjects. All 11 are available as a package as SP-330. See order blank on p. 6.)

Liquid Nitriding is New Production Tool

Based on paper by

J. H. SHOEMAKER, Kolene Corp. and

GEORGE BIDIGARE,
Commercial Steel Treating Corp.

A LIQUID nitriding process has been developed which achieves the goal of increasing the wear and fatigue resistance of various steels without a brittle white layer. The process, known as Tufftride, can be applied to low carbon, alloy, stainless, tool, and heat-resistant steels, as well as to grey, alloy, nodular or ductile, malleable, and pearlitic irons. Time cycle is short.

The process is carried out in low carbon or mild steel containers in externally heated gas or electrically fired furnaces capable of holding and controlling operating temperatures of the molten salt bath within 1000–1050 F. Bath stability is good under production conditions.

When low carbon steel is immersed in the salt bath, decomposition of the salt in contact with the steel liberates specific amounts of carbon and nitrogen. These have vastly different solubility rates when subjected to the same conditions of diffusion in ferrite. Carbon is ten times less soluble than nitrogen and very quickly forms iron carbide particles on the surface of the part. These carbides act as nuclei so that the nitrogen will precipitate at the surface to form the nonbrittle and desirable iron nitrides Fe_3N and Fe_4N. The outer surface, known as the compound layer, is revealed by X-ray diffraction to be approximately 6.7% Fe_3N – 5.8% Fe_4N, the balance iron carbide Fe_3C with no brittle Fe_2N.

The nitrided surface of plain carbon steel is tough and wear-resistant and has unusual antigalling and antiseizing properties, even when run without lubrication. Distortion and growth after nitriding of finish machined and ground parts is negligible, if parts are free of residual stresses before treating.

To Order Paper No. 178B . . .
from which material for this article was drawn, see p. 6.

New Concept Aids Vehicle Handling

Based on paper by

WALTER BERGMAN, Ford Motor Co.

THE EFFECT of traction on cornering force is one of the major factors affecting the handling of an automobile, and it can be predicted by using a new concept of spring interaction.

To understand tire behavior one should think of it as a three-dimensional spring system transmitting forces in vertical, lateral, and longitudinal directions. A tire is not an air spring. If it were, a load increase would result in an increase in pressure, whereas the true result is an increase in the tire contact area with virtually no pressure change.

Forces applied to any one of the three springs produces bending of the other two, resulting in a decrease in their respective rates. The phenomenon is called the interaction effect. It is a major factor counteracting nonlinear tire characteristics, and so produces approximate linear relationship between vertical load and deflection within a limited range of applied loads. It also causes a reduction in overall lateral stiffness of a tire, with an increase in vertical load. Finally, it is one of the two principal factors reducing internal tire force when power is applied the other being the effective lateral coefficient of friction.

Lateral tire characteristics are described by lateral tire force and aligning torque. Lateral tire forces are determined by lateral deformations of a tire both inside and outside the contact area. When camber thrust acts in the direction of lateral tire force, it has two opposite effects — it is additive to lateral tire force, but it reduces the latter because of reduction in effective lateral coefficient of friction.

Cornering force and traction force are composed of components of lateral tire force, camber thrust, and effective tractive effort acting, respectively, perpendicular and parallel to the direction of motion. Moderate power application increases elastic trail and aligning torque, while with severe power application the aligning torque decreases.

The effect of power application on cornering has important implications in car handling, since it produces oversteer on rear-wheel-drive vehicles and understeer on front-wheel-drive ones. Cutting off power on a front-drive vehicle in a turn results in an oversteering effect, caused by an increase in cornering forces on both driving tires. Usually, cornering force reduction at inner tire is greater than on outer tire.

To Order Paper No. 186A . . .
from which material for this article was drawn, see p. 6.

96 Cars Rated for Rumble in 1959 CRC Road Test Program

THE 1959 CRC road test program shows that rumble requirements of passenger cars on the road *can* be determined in terms of LIB reference fuels. And according to CRC Report 344, "Analysis of the 1959 Road Rating Exchange Data," the present LIB technique is suitable for survey purposes, although use of additional reference fuels may be desirable.

The 1959 program was initially set up to determine two things:

(1) Rumble requirements of cars in terms of the manifold vacuum that produces trace rumble when using a series of LIB (leaded iso-octane benzene) reference fuels.

(2) Rumble ratings of two test fuels in terms of LIB reference fuels.

The first part of this program used cars having engines in a deposit condition corresponding to at least 3,000 miles of customer-type operation. Rumble was measured for 96 cars by 19 participating laboratories. Of the 96 cars, 83 were 1959 models with standard compression ratio engines, and 13 had higher-than-standard compression ratio engines. At least 15 of each of the five specified standard compression ratio cars were used to determine the rumble characteristics for a particular make.

Data gathered from the program form the basis of rumble requirement distribution curves for each sample of car tested. In addition, a number of engine operating variables were inspected to explore the influence of these variables on rumble requirements.

The second part of the 1959 road test program utilized the same cars as did the first. The two fuels tested were:

(1) RMFD-100-59 as specified and supplied for the 1959 CRC-Motor Equipment Survey Program.

(2) 100% toluene plus 3.0 ml TEL/gal.

These fuels were tested in 78 cars by 15 laboratories. Of the 78 cars, 68 were 1959 models with standard compression ratio. Ten were equipped with higher-than-standard compression ratio engines. Although the two fuels were tested in 78 cars, ratings could be obtained in only 19 of the cars.

Both test fuels were rumble-free in the remaining 59 cars and ratings, therefore, could not be assigned. Of the 19 cars in which ratings were obtained, 12 were 1959 standard compression ratio models and seven were higher-than-standard compression ratio models.

A description of the reference fuels, test cars, and test techniques are given in CRC Report 344, along with the following conclusions.

(1) The technique used in this program was suitable for measuring the rumble requirements of cars in terms of the LIB reference fuels.

(2) The LIB reference fuels did not bracket the rumble requirements of the cars tested . . . since 31 of the 83 standard compression ratio cars gave no rumble on 0 LIB while two gave trace rumble on 100 LIB. Although all 13 of the modified compression ratio cars gave trace rumble or higher on 0 LIB, three gave trace rumble on 100 LIB.

(3) Of the five standard compression ratio car makes tested, two were less prone to rumble on the LIB reference fuel system than the other three.

(4) Rumble ratings could not be assigned to RMFD-100-59 and toluene + 3.0 ml TEL/gal because of the wide variations in results. These variations in ratings for the same fuel suggest the importance of engine design and deposit condition on rumble tendency of a particular fuel hydrocarbon composition. However, additional tests would be required to determine the repeatability and significance of ratings obtained by this technique.

This report contains 36 pp. including charts, graphs, and appendices.

■ **To Order CRC Report No. 344 . . .** from which material for this article was drawn, see p. 6.

Numerical Control Calls for Organization, Procedure Changes

Based on report by panel secretary

R. C. MILLER
General Motors Corp.

NUMERICALLY CONTROLLED MACHINES have necessitated a reorientation of procedures, and in some cases of organization, in order to implement engineering, tooling, and process planning under this new concept.

The introduction of numerical control results in many fundamental organizational changes. The various departments must adjust their functions to this technique and learn to recognize its new design and fabrication capabilities. Certain specific areas, such as the coordination of tooling and fixtures and the maintenance of cutting tools, assume increased importance. Careful selection of personnel who can deal with highly complex electrical, electronic, and hydraulic controls is important.

Producing parts by numerical control with little or no human intervention, requires that the judgment and skill of an operator be replaced by a set of commands a numerical control can execute. The detailed geometric description of the part to be produced must be specified in a new way, the manner depending upon the machines available and the means of processing the data available to the user. New drafting procedures must be evolved, computers and their use must be studied. The small user must decide whether to use manual data preparation methods or parts programming facilities located at various computing centers. The large user must decided whether to purchase computing facilities and train people to program. Modern high-speed computing facilities have made data preparation for complex parts economically feasible, and the exploitation of new computing facilities and new programming techniques will result in lower costs for numerical control.

Numerical control introduces problems in implementation and integration. Implementation is the selling of the idea, the acquisition, installation, initial operation, and demonstration of the ability to do a job. Integration is the nurturing of a project until it has become a regular, moving, working force in an accepted manufacturing process. This means that each department has accepted its normal and logical responsibility and is carrying its share of the load.

Serving on the panel Numerical Control of Machines and Processes upon which this article is based, in addition to the panel secretary, were: **R. B. Colten**, GMC; **P. D. Tilton**, Stanford Research Institute; **E. G. Newman**, IBM; **J. B. Rankin**, Convair Division of General Dynamics Corp.; and **B. K. Ledgerwood**, Control Engineering Magazine.

(This article is based on a report of one of 11 panels on production subjects. All 11 are available as a package as SP-330. See order blank on p. 6.)

SAE NEWS

13 SAE Men in Group Honored by AMA Officials

THIRTEEN MEMBERS were among 19 men honored recently by officials of the Automobile Manufacturers Association for "application of individual talents toward the special goal of the general public welfare." The citations referred to the cooperative approach made by these pioneers to the work of state motor vehicle administrators and automobile and lamp manufacturers on motor vehicle lighting problems.

Formalized through committees of the Automobile Manufacturers Association and the American Association of Motor Vehicle Administrators, the cooperative project — conceived 25 years ago — has led to continued headlighting advances and to standardization and improvements in related lighting areas. SAE-member state administrators who received framed citations were Wilbur L. Cross of Connecticut and Alfred W. Devine, Massachusetts.

SAE-members from industry cited included two Past Presidents of the Society: Jesse G. Vincent, who was SAE president in 1920, and John H. Hunt, president in 1927. Don Blanchard of the SAE staff was also cited. (Blanchard has served for a number of years as secretary of the Engineering Subcommittee of the Engineering and Vehicle Inspection Committee of the AAMVA.)

Other SAE-member engineers from industry cited were: Carl Breer, Philip J. Kent, L. L. Beltz, Ormund E. Hunt, Floyd F. Kishline, Ray E. Carlson, Val J. Roper, and Lyman A. Wine.

Presentation of the citations was made by Ralph H. Isbrandt, chairman of AMA's Engineering Advisory Committee, at a meeting in Detroit, which was addressed by SAE's John A. C. Warner.

The various elements of the cooperative industry-administrator program, Warner noted, were first fused together under the sponsorship of Ormund E. Hunt, then vice-president for engineering of General Motors.

"Each of the cooperating participants," Warner pointed out, "brought into the picture (1) a recognition of his own responsibilities, and (2) a wholehearted contribution of his talents and facilities."

Chicago Big Step to Summer Meeting Aims

THIS YEAR'S SUMMER MEETING went a long way to achieve the Engineering Activity Board's aims for this important annual SAE event, according to EAB Chairman Harry F. Barr. Chief among these aims are:

- To make the Summer Meeting available to an ever greater number of SAE members.
- To emphasize the technical aspects of the meeting.

Barr's comments accompanied a release of detailed statistical data on overall and session attendance at the 1960 Summer Meeting in Chicago last June. These data, Barr points out, clearly tell the prograss made toward accomplishing these objectives.

The analysis shows, among other things, that the 2087 who attended the 1960 Summer Meeting in Chicago set a new all-time record for Summer Meeting attendance. . . . The highest previous attendance was in 1956 at Atlantic City. The highest total attendance at French Lick (where Summer Meetings were held from 1946 to 1951) was 1400 in 1950.

Technical Sessions Up

Technical sessions in Chicago totaled 34 — as against the 23 in 1959 at Atlantic City. An average session attendance at Chicago was just under 100. (Biggest Chicago session was 224.)

Chicago attendance at sessions sponsored by the Passenger Car, Truck and Bus, and Powerplant Activities was especially good as compared with 1959 Atlantic City performance.

In Chicago, 620 took in the five Powerplant-sponsored sessions, as against 292 at the three sessions in Atlantic City. Seven Passenger-Car-sponsored sessions in Chicago attracted 434 engineers, as against 196 at two sessions in Atlantic City last year . . . while only two Truck-and-Bus-sponsored sessions in Chicago drew 214 MORE than did three Atlantic City sessions — 352 vs 138.

"Every Activity group," Barr said in releasing the figures, "is in process of improving its paper-selection techniques and intensifying its development of fresh sources for material for papers.

"At the same time, program planning committees are giving more careful attention to positioning and scheduling of individual sessions. Their aim is to have each session scheduled at a time and place where the particular subject matter will provide maximum member service.

"I sincerely feel even greater meetings are ahead with the programs now planned for the future — to pull varied geographic areas into attendance."

PRESENT TO RECEIVE CITATIONS from Ralph Isbrandt, chairman of the Engineering Advisory Committee of the Automobile Manufacturers Association, recently were — left to right: Back Row — J. H. Hunt, Alfred W. Devine, Wilbur L. Cross, H. Murray Northrup, Robert N. Falge, Val J. Roper, Don Blanchard, Lee C. Richardson, and L. L. Beltz. Front Row — Philip J. Kent, Ormund E. Hunt, Isbrandt, Larry S. Sheldrick, and Lyman A. Wine.

SAE's first National Powerplant Meeting

THE first SAE National Powerplant Meeting, with technical sessions planned by the newly expanded SAE Powerplant Activity (an expansion of SAE's former Diesel Engine Activity), will be held in Cleveland at the Sheraton-Cleveland Hotel, October 31 through November 2. The 3-day meeting will exceed by a full day the 2-day gatherings traditional for the former Activity. The additional sessions will encompass programs added by the Gas Turbine and Small Industrial and Marine Engine Subcommittees of the Powerplant Activity.


Gregory Flynn, Jr.

Technical sessions at the meeting will feature papers from Caterpillar Tractor Co. and American Marc Corp. on new small diesel engines; a report from England on the Coventry Climax aluminum engine; a symposium on small turbochargers; and other new engine and component developments.


W. H. Upson

An afternoon and evening visit will be made to the Aluminum Co. of America plant. SAE members and guests will tour the facility, dine at the plant, and attend meetings on stress analysis and aluminum processing.

On Tuesday evening, November 1, **W. H. Upson,** the famous humorist and author of the Saturday Evening Post "Earthworm Tractor" stories, will talk at a dinner meeting at the Thompson Auto Album and Aviation Museum.

T. R. Thoren has been named by the Engineering Activity Board as Planning Committee Chairman for the meeting. Serving with him on the committee are J. R. Doyle, H. F. Hostetler, T. C. Noon, R. A. Pejeau, R. R. Robinson, R. F. Schaefer, L. L. Young, W. Weinkamer, SAE Cleveland Section Chairman E. H. Scott, and Powerplant Activity Chairman **Gregory Flynn, Jr.**


T. R. Thoren

SAE Seeks Offers of Papers For April Aeronautic Meeting

THE committee planning next spring's SAE National Aeronautic Meeting is issuing a call for papers on 31 topics. This Meeting is scheduled for April 4–7, 1961 at the Commodore Hotel in New York.

The topics are listed in the accompanying box. They range from **boost rockets for space vehicles** to **approach and landing problems and take-off performance for transport aircraft** to **producing honeycomb structures.** Engineers desiring to offer papers are invited to request a list of the 31 topics with more detail and the special form for submitting abstracts of papers offered. It is not necessary to submit the complete paper, the Committee emphasizes. Offers should be submitted to:

Planning Committee for the
SAE National Aeronautic Meeting
(April 1961)
Society of Automotive Engineers
485 Lexington Avenue
New York 17, N. Y.

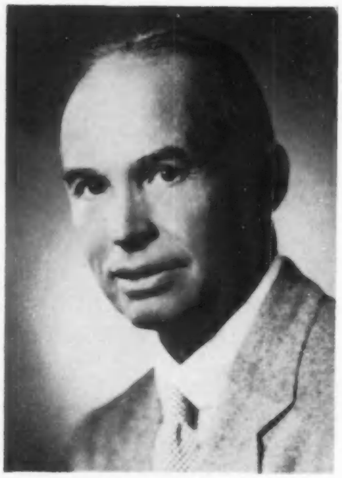
The planning committee is headed by Co-chairmen Emerson W. Conlon, Assistant Director of Research (Power Plants), National Aeronautics and Space Administration, and Glenn W. Periman, Project Coordinator, Columbus Division of North American Aviation. The committee's first job was to choose session topics from the lists of "major technical problem areas" compiled by the SAE Aerospace Powerplant, Aerospacecraft, and Air Transport Activity Committees, and other SAE groups. This was done in July.

The committee will meet in mid-September to select papers for presentation at the Meeting next April. On the basis of experience with the similar Meeting last April, it is expected that about 300 papers will be offered and about 75 accepted.

Session topics on which papers are sought . . .

- Boost rockets for space vehicles
- Small rockets for space vehicles
- Space vehicles
- Auxiliary power sources for space vehicles
- Human engineering applied to space flight, and missile weapons systems
- Navy underwater missiles
- Air-breathing propulsion up to Mach 10
- Nuclear engines
- Radiation effects on materials and equipment
- Turbine engines for transport aircraft
- Sound suppressors and jet reversers
- Sonic fatigue and effects of aerodynamically and engine-induced vibration
- Industrial and marine applications of aircraft turbine engines
- Aircraft flight control
- Provision for en route all-weather operation
- New piloting techniques with jet transports
- Approach and landing problems and take-off performance
- Cargo transports
- Air cargo loading systems
- Supersonic air transports
- VTOL and STOL aircraft
- Ground-effect machines
- Army aviation
- Hydrofoil boats
- High-strength, extreme-temperature structures
- Reliability
- Exact linear measurement
- New production techniques
- Producing honeycomb structures
- Heat-treating with no warpage
- Production management
- Other topics

Grover Loening Is 1960 Guggenheim Medalist



Grover Loening

GROVER LOENING — SAE member since 1916 — is Daniel Guggenheim Medalist for 1960. He was selected by the Board of Award "as pioneer, engineer, public servant — for a lifetime devoted to the advancement of aeronautics in America."

Armed with the first degree in aeronautics granted in the United States, and his thesis as his first textbook, Loening left Columbia University to be assistant to pioneer Orville Wright. Two years later, Loening became the first chief engineer of the embryo Aviation Section of the U. S. Army at San Diego — where he compiled his second textbook "Military Airplanes," which was used by the U. S. Army, Navy, and British Royal Flying Corps as standard for training their aviators.

In 1917, he organized the Loening Aeronautical Corp (merged 12 years later with Curtiss Wright.) In 1923, the U. S. Army assigned to his company development of the first amphibious airplane — the Loening Amphibian — which was put into wide use by the Military, Naval, Coast Guard, Airmail, airline, and private owner operation.

Loening received the Distinguished Service Award for designing and building the first strut-braced monoplane during World War I . . . and the Collier Trophy for development of "Air Yacht" — the monoplane flying boat that won so many World records. In 1950, he was awarded the Wright Brothers Memorial Trophy; and in 1955, the Exceptional Civilian Service Medal.

Tours of duty in Government service included: Aircraft advisor to the Maritime Commission and to the War Production Board; head consultant for National Advisory Committee for Aeronautics; and chief of research of the President's Air Policy Commission.

The award presentation will be made by the Institute of Aeronautical Sciences at its Honors Night Dnner, January 24, 1961.

SAE members who participated in the award decision, in collaboration with members of ASME and IAS, are: J. B. Wassall, Jerome Lederer, William F. Ballhaus.

Why are there three . . .

. . . subcommittees of the Membership Committee, namely, Engineering Activity, Sections Membership, and Technical Membership Program Subcommittees?

Membership Chairman W. J. Lux answers by asking: "Do you always enter your house by the same door? Neither do SAE members. . . . So, we plan to have *all* doors open — and staffed with men ready to help the prospect take advantage of SAE membership."

SAE National Meetings

1960

- **October 10–14**
  National Aeronautic Meeting including Third AFORS Astronautic Symposium and Aerospace Manufacturing Forum and Engineering Display, The Ambassador, Los Angeles, Calif.
- **October 25–27**
  National Transportation Meeting, Hotel Leamington, Minneapolis, Minn.
- **October 31–November 2**
  National Powerplant Meeting, Sheraton-Cleveland, Cleveland, Ohio.
- **November 2–4**
  National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

1961

- **January 9–13**
  SAE International Congress and Exposition of Automotive Engineering (Annual Meeting), Cobo Hall, Detroit, Mich.
- **March 13–17**
  National Automobile Week (National Automobile and Production Meetings), The Sheraton-Cadillac, Detroit, Mich.
- **April 4–7**
  National Aeronautic Meeting (including production forum and engineering display), Hotel Commodore, New York, N. Y.
- **June 4–9**
  Summer Meeting, Chase-Park Plaza, St. Louis, Mo.

SAE Section Meetings

CHICAGO

Oct. 11 . . . K. A. Austin and L. S. Votre, Lycoming Division, AVCO Corp. "Turbine-Driven Amphibians — New Trend in Fast Assault Craft." Knickerbocker Hotel, Chicago. Social Half-Hour 6:15 p.m. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Feature: Colored movies covering Hydrofoil Application to Military Craft.

INDIANA

Oct. 20 . . . "Maintenance Problems on Highway Trucks." ' Continental Hotel, Indianapolis. Dinner 6:30 p.m. Meeting 8:00 p.m.

METROPOLITAN

Oct. 6 . . . Paul A. Bennett, Fuels & Lubricants Dept., Research Labs., General Motors Corp. "Automobile Manufacturing Industry Engine Oil Evaluation." Brass Rail Restaurant, Fifth Ave. & 43rd St., New York City. Cocktails 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.
Oct. 13 . . . Frank H. Macy, The Durham Co. "Alternators." Roger Smith Hotel, Lexington Ave., and 47th St., New York City. Luncheon 12:00 Noon.
Oct. 19 . . . Maynard L. Pennell, Boeing Airplane Co. "Supersonic Aircraft Developments." Henry Hudson Hotel, 57th St. & 9th Ave., New York City. Meeting 7:45 p.m.

NORTHERN CALIFORNIA

Sept. 28 . . . David J. Jay, Ford Motor Co. "Levacar Project." Engineers Club, 101 Sansome St., San Francisco. Dinner 6:30 p.m. Meeting 7:30 p.m.

NORTHWEST

Oct. 9 . . . R. O. Gordon, Power Steering Division, Vickers, Inc. "History and Design and Application of Power Steering." Stewart Hotel, Seattle. Dinner 6:30 p.m. Meeting 8:00 p.m.

ROCKFORD-BELOIT

Sept. 26 . . . Aircraft Activity Meeting. Wagon Wheel Lodge, Rockton, Ill. Dinner 6:45 p.m. Meeting 8:00 p.m.

Rambling through the Sections

ELECTRIC CARS are in the picture for the near future, due to a recent break through in power battery construction, according to Robert McGill of C. Brewer & Co., who spoke at **HAWAII SECTION** June 28.

Harry K. Sproul (standing left) receives a certificate for his service as Section chairman during 1959–1960 at HAWAII SECTION'S June meeting. Presenting it is Morito Tsutsumi, 1960-1961 chairman. Also present at the meeting were H. W. Widener, Union Oil Co. (standing right), and (seated, left to right) C. H. Ahlf of C. Brewer & Co., speaker R. K. McGill of C. Brewer & Co., and H. T. Bradley, U.S. Army.

FOREIGN Papers Roll in for ICAE

ELEVEN COUNTRIES already have responded with offers of approximately 60 technical papers for SAE's International Congress of Automotive Engineering in Detroit next January. Invitations to 56 overseas sources of current technical information in 15 countries were dispatched last May by President Chesebrough and T. B. Rendel, chairman of SAE's International Information Committee. Now, these offered papers are being made available to appropriate Activity Committees, which are already busy developing papers, programs and sessions for this 1961 SAE Annual Meeting.

The wealth of papers being offered insures actual presentation of only those determined to be of highest value and greatest current usefulness. Even the record number of 73 sessions made possible by Cobo Hall's vast facilities will be able to accommodate at this one meeting less than 50% of the fine papers being offered from overseas engineers.

The Activity Committees are giving very careful study, however, to *every* paper offered. And many committeemen are concurring with the statement made last week by one committee official, who said:

"These offered papers in themselves constitute a major step in exchange of technical information between overseas engineers and the leading engineers of American automotive industry.

"Each paper offer is made through a specific digest or outline. These digests are giving our Activity Committee engineers a fine, first-hand picture of what is going on in automotive engineering throughout the world. The several hundred leading American engineers who comprise our Activity committees, in other words, are being greatly benefited by the opportunity to examine and discuss the digests themselves . . . and the problems and solutions which they reveal.

"So, *every* paper-idea submitted is carrying a message and information to a group of leading American specialists in the field to which the paper is directed. Those which are selected for presentation, of course, will carry similar messages to all SAE members and others who attend the sessions."

In every case, the Activity group is doing its best to make prompt decisions.

SAE Letters from Readers

From:
W. P. Barnes (M'50), SAE Faculty Advisor
Associate Professor, Mechanical Engineering
University of Idaho
Moscow, Idaho

Dear Editor:

In checking over the SAE student branch files in our engineering library, I find that copies of the 1955 and 1957 SAE Transactions are missing. Would it be possible to obtain extra copies of these particular volumes as our students use them a great deal for reference work in the jet propulsion and internal combustion engine courses.

(Ed. note: SAE Headquarters was able to supply a 1955 SAE Transactions. . . . If some member can supply a 1957 volume, we are sure Professor Barnes would be glad to hear from him directly.)

SAE Section Officers 1960-61

Alberta Group

Frank R. Rhodes .... Chairman
Roy L. Larson .... Vice-Chairman
Edmonton
Albert A. Nicholls .... Treasurer
George A. C. Higgs .... Secretary
Address of Secretary — 2211 Ninth Ave., N. W., Calgary, Alberta, Canada

Atlanta

William Law .... Chairman
Paul A. Young .... Vice-Chairman
Fred N. Dickerman ... Vice-Chairman
Aircraft
F. A. Buchanan, Jr. ... Vice-Chairman
Fuels and Lubricants
Charles B. Sanford, Jr. Vice-Chairman
Transportation and Maintenance
Roland Lyons, Jr. .... Treasurer
John M. Malone .... Secretary
Address of Secretary — 241 Chelsea Dr., Decatur, Ga.

Baltimore

William Kaplan .... Chairman
George A. Bamford ... Vice-Chairman
J. C. Hussong .... Vice-Chairman
Aeronautics
Dale E. Woomert ..... Vice-Chairman
Fuels and Lubricants
Sherod L. Earle ...... Vice-Chairman
Powerplant
John W. S. Wheatley .. Vice-Chairman
Transportation and Maintenance
James H. Rock .... Treasurer
John W. Lippert .... Secretary
Address of Secretary — 1507 Tredegar Ave., Catonsville 28, Md.

British Columbia

S. G. Jones .... Chairman
Henry C. Givins ...... Vice-Chairman
George T. Perry ...... Vice-Chairman
Fuels and Lubricants
A. J. Leger .... Vice-Chairman
Transportation and Maintenance
Fred P. Holmes .... Treasurer
R. B. Thicke .... Secretary
Address of Secretary — Pacific Truck & Trailer Ltd., 1460 Franklin St., Vancouver, B. C., Canada

Buffalo

Robert E. Lenz .... Chairman
Sydney E. Lesse ...... Vice-Chairman
William D. Huston ... Vice-Chairman
Rochester
William Close .... Treasurer
Merle S. Day .... Secretary
Address of Secretary — 129 Harrison Ave., Kenmore 23, N. Y.

Central Illinois

W. H. McGlade .... Chairman
L. E. Johnson .... Vice-Chairman
F. H. Hart .... Vice-Chairman
Decatur
O. H. Cannedy ...... Vice-Chairman
Springfield
A. L. Jacobs .... Treasurer
R. E. Seyfried .... Secretary
Address of Secretary — 1718 Westaire, Peoria, Ill.

Chicago

Edward D. Hendrickson ... Chairman
Philip J. Sperry ...... Vice-Chairman
Howard J. Williams .. Vice-Chairman
Aircraft
Elmer H. Snyder ..... Vice-Chairman
Engineering Materials and Production
Frederick T. Finnigan Vice-Chairman
Fuels and Lubricants
O. J. Kelley .... Vice-Chairman
Parts & Accessories
John K. Nemeth ..... Vice-Chairman
Passenger Car
Lee D. Evans .... Vice-Chairman
Tractor Industrial Power and Diesel Engine
David C. Stukey ...... Vice-Chairman
Transportation and Maintenance
C. L. Small .... Vice-Chairman
Truck and Bus
Clarence Martin ...... Vice-Chairman
Fox Valley Division
W. R. Williams ...... Vice-Chairman
South Bend Division
Wesley H. Day .... Treasurer
I. R. Dawson .... Secretary
Address of Secretary — Aluminum Co. of America, 520 N. Michigan Ave., Chicago 11, Ill.

Cincinnati

Arthur R. Ehrnschwender .. Chairman
F. P. Waldmann ...... Vice-Chairman
Edward B. Lohaus .... Treasurer
John F. Dooley, Jr. .... Secretary
Address of Secretary — Cincinnati Gas & Electric Co., 2139 Dana Ave., Cincinnati 7, Ohio

Cleveland

L. L. Young .... Chairman
T. Cyril Noon ...... Vice-Chairman
F. A. Wilcox .... Vice-Chairman
Aeronautics
R. Z. Farkas .... Vice-Chairman
Akron-Canton
R. A. Pejeau .... Vice-Chairman
Fuels and Lubricants
H. F. Hostetler ...... Vice-Chairman
Powerplant Activity
K. J. Sorace .... Vice-Chairman
Production
R. C. Austin .... Vice-Chairman
Transportation and Maintenance
E. C. Curtis, Jr. ...... Vice-Chairman
Truck and Bus
J. R. Doyle .... Treasurer
H. C. Simons .... Secretary
Address of Secretary — Eaton Mfg. Co., Heater Division, E. 65th St. & Central Ave., Cleveland 4, Ohio

Colorado Group

Joseph T. Keeley .... Chairman
Jack P. Goodman .... Vice-Chairman
Chester Wentworth .... Treasurer
V. H. Knowles .... Secretary
Address of Secretary — Mack Trucks, Inc., 4850 Vasquez Blvd., Denver 16, Colo.

Dayton

George W. Jackson .... Chairman
William A. Frye ...... Vice-Chairman
Thomas J. Lord ...... Vice-Chairman
Aeronautics
Ludwig A. Majneri .... Vice-Chairman
Columbus
Vernon L. Durrstein . Vice-Chairman
Springfield
Rodger E. Geller .... Treasurer
Arthur R. Shaw .... Secretary
Address of Secretary — Delco Moraine Division, GMC, Dayton, Ohio

Detroit

M. M. Roensch .... Chairman
C. W. Ohly .... Vice-Chairman
Charles W. Williams .. Vice-Chairman
Aeronautic and Missile
Robert Anderson ..... Vice-Chairman
Body
Charles M. Heinen ... Vice-Chairman
Engineering Materials
William A. McConnell .. Vice-Chairman
Junior
J. Z. DeLorean .... Vice-Chairman
Passenger Car
Peter H. Ponta ...... Vice-Chairman
Production
W. H. Schomburg, Jr. . Vice-Chairman
Regional
W. S. Coleman, Jr. ... Vice-Chairman
Student
E. R. Klinge .... Vice-Chairman
Truck and Bus
G. A. Delaney .... Treasurer
H. C. MacDonald .... Secretary
Address of Secretary — 1621 Club Dr., Rt. 3, Bloomfield Hills, Mich.

Fort Wayne

M. J. Slater .... Chairman
R. D. Ramsey .... Vice-Chairman
K. W. Gordon .... Treasurer
Richard S. Johnson .... Secretary
Address of Secretary — 5163 Northcrest Dr., Fort Wayne, Ind.

Hawaii

Morito Tsutsumi .... Chairman
George K. Sereno .... Vice-Chairman
Walter H. Grasser .... Vice-Chairman
Aeronautics
J. Lowell Twidwell ... Vice-Chairman
Hawaii
Glen J. Adams .... Vice-Chairman
Maui
Fred L. Helbush .... Treasurer
Harry D. Smith .... Secretary
Address of Secretary — 636 Elepaio St., Honolulu, Hawaii

Indiana

Darrell D. Don Carlos Vice-Chairman
R. M. Tuck .... Vice-Chairman

Milton D. Parker .... Vice-Chairman
Aircraft
John C. Walter ...... Vice-Chairman
Diesel Engine
Jack D. Bryan .... Vice-Chairman
Passenger Car
George W. Yount .... Vice-Chairman
Transportation and Maintenance
M. B. Emig .... Vice-Chairman
Truck and Bus
Thomas I. Monroe .... Treasurer
B. A. Woodhull .... Secretary
Address of Secretary — 2219 Sims Dr., Columbus, Ind.

Kansas City

Allen H. Corbet .... Chairman
Leonard R. Buff ...... Vice-Chairman
Francis J. Boyle ...... Vice-Chairman
Aeronautics
Gene R. McLaughlin . Vice-Chairman
Fuels and Lubricants
Darrell L. Bryan ...... Vice-Chairman
Transportation and Maintenance
O. Gooch Phillips, Jr. .... Treasurer
Frederic T. Weisman ...... Secretary
Address of Secretary — 8401 W. 91st Terrace, Overland Park, Kansas

Metropolitan

C. S. Ryan .... Chairman
L. A. Douglass .... Vice-Chairman
C. M. Rice .... Vice-Chairman
Aeronautics
J. E. Davis .... Vice-Chairman
Air Transport
R. W. Meals .... Vice-Chairman
Diesel Engine
B. H. Carpenter ..... Vice-Chairman
Fuels and Lubricants
H. V. Chioffe .... Vice-Chairman
Passenger Car and Body
J. C. Crawford .... Vice-Chairman
Students
G. E. Kelm .... Vice-Chairman
Transportation and Maintenance
H. J. Hannigan .... Treasurer
Jere T. Farrah .... Secretary
Address of Secretary — Sunview Dr., Glen Cove, N. Y.

Mid-Continent

W. J. Ewbank .... Chairman
I. E. Flaa .... Vice-Chairman
C. L. Cotton .... Vice-Chairman
Aircraft
L. W. Okon .... Vice-Chairman
Fuels and Lubricants
R. E. Linnard .... Vice-Chairman
Transportation and Maintenance
H. M. Carey .... Treasurer
O. L. Spilman .... Secretary
Address of Secretary — 616 E. Detroit, Ponca City, Okla.

Mid-Michigan

Walter F. Long .... Chairman
Raymond J. Schultz .. Vice-Chairman
G. William Moody .... Treasurer
Karl Schwartzwalder ...... Secretary
Address of Secretary — AC Spark Plug Division, GMC, 1300 N. Dort Hwy., Flint 2, Mich.

Milwaukee

G. A. Rea .... Chairman
James W. Mohr ...... Vice-Chairman
F. J. Hartshorn, Jr. .... Treasurer
D. R. Neeld .... Secretary
Address of Secretary — Engine Division, Nordbert Mfg. Co., 3037 S. Chase Ave., Milwaukee 1, Wisc.

Mohawk-Hudson

John P. Thomas .... Chairman
W. F. Venneman ...... Vice-Chairman
John H. De Witt ...... Vice-Chairman
Albany
C. Kenneth Hunt ..... Vice-Chairman
Schenectady
J. W. Cummings .... Treasurer
Fil L. Fina, Jr. .... Secretary
Address of Secretary — County of Saratoga, Hwy. Dept., 31 Woodlawn Ave. Saratoga Springs, N. Y.

Montreal

Barstow H. Miller .... Chairman
William E. MacKenzie Vice-Chairman
R. F. Stapells .... Vice-Chairman
Aircraft
George Donato ...... Vice-Chairman
Students
Ian W. Shepherd ..... Vice-Chairman
Transportation and Maintenance
John W. Hammond .... Treasurer
Gaston Beauchamp .... Secretary
Address of Secretary — Montreal Transportation Commission, 8845 St. Lawrence Blvd., Montreal, Quebec, Canada

New England

George T. Brown .... Chairman
Draper M. Harvey .... Vice-Chairman
Richard L. Charlesworth .. Treasurer
John E. Jorgensen .... Secretary
Address of Secretary — 11 Rustlewood Dr., Canton, Mass.

Northern California

Irving M. Harlow .... Chairman
Ernest S. Starkman .. Vice-Chairman
Ralph H. K. Cramer .. Vice-Chairman
Aeronautics
Eldon C. Beagle ...... Vice-Chairman
Diesel Engine
Paul D. Hobson .... Vice-Chairman
Fuels and Lubricants
Donald C. Wimberly .. Vice-Chairman
Regional
Forest W. Fingerle ... Vice-Chairman
Students
Charles R. Coffey .... Vice-Chairman
Transportation and Maintenance
Harrison W. Sigworth ..... Treasurer
P. L. Pinotti .... Secretary
Address of Secretary — Standard Oil Co. of California, 225 Bush St., San Francisco, Calif.

Northwest

Louis W. Schroeder .... Chairman
W. M. Brown .... Vice-Chairman
Ben F. Dotson .... Vice-Chairman
Aircraft
E. J. Wood .... Vice-Chairman
Fuels and Lubricants
A. D. Bullock .... Vice-Chairman
Transportation and Maintenance
Albert T. Baines .... Treasurer
Merl E. Earnheart .... Secretary
Address of Secretary — Truck Welding & Equipt. Co., 739 Ninth Ave., N., Seattle 9, Wash.

Ontario

Lloyd W. Nourse .... Chairman
Lloyd A. Hassell ...... Vice-Chairman
Carl S. Finkle .... Vice-Chairman
Hamilton
J. M. Delorme .... Vice-Chairman
Kitchener
C. N. Reatherford .... Vice-Chairman
London-Sarina
John K. Abel .... Vice-Chairman
Niagara Peninsula
J. S. Munro .... Vice-Chairman
Oshawa
Carl E. Lindros ...... Vice-Chairman
Windsor
Sydney E. Swallow .... Treasurer
George R. Jackson .... Secretary
Address of Secretary — 343 Durie St., Toronto, Ontario, Canada

Oregon

Mel L. Gordon .... Chairman
Fred D. Fulton .... Vice-Chairman
A. W. Anderson ...... Vice-Chairman
Diesel Engine
Jay L. Phelps .... Vice-Chairman
Fuels and Lubricants
W. H. Paul .... Vice-Chairman
Students
Robert B. Gaulke .... Vice-Chairman
Transportation and Maintenance
Victor V. Cox .... Vice-Chairman
Truck and Bus
Don M. McGuire .... Treasurer
John R. Deffenbaugh ...... Secretary
Address of Secretary — 6024 S. E. 55th Ave., Portland 6, Ore.

Philadelphia

Leon F. Dumont .... Chairman
Edward L. Dold ...... Vice-Chairman
George C. Flynn ...... Vice-Chairman
Aircraft
William Schreiber .... Vice-Chairman
Fuels and Lubricants
Richard E. H. Berryman Vice-Chairman
Transportation and Maintenance
Robert A. Winemiller . Vice-Chairman
Truck and Bus
Karl F. Green .... Treasurer
Laurence J. Test .... Secretary
Address of Secretary — Atlantic Refining Co., 2700 Passyunk Ave., Philadelphia, Pa.

Pittsburgh

M. J. Boegel .... Chairman
D. W. Gow .... Vice-Chairman
L. C. Borell .... Vice-Chairman
Oil City Region
H. H. Donaldson, Jr. ...... Treasurer
W. C. Weltman, Jr. .... Secretary
Address of Secretary — Aluminum Co. of America, Sales Dev. Division, Box 1012, New Kensington, Pa.

Rockford-Beloit

J. Bruce Ingold .... Chairman

... Continued

SAE Section Officers 1960-61

. . . Continued

Wilson P. Green . . . Vice-Chairman
Philip C. Mosher . . . Vice-Chairman
Aircraft
Walter C. Arnold . . . Vice-Chairman
Powerplant
Roger Birdsell . . . Vice-Chairman
Production
Evert L. Venstrom . . . Vice-Chairman
Tractor and Farm Machinery
Forest C. Hile . . . Vice-Chairman
Truck and Bus
Jay R. Sturm . . . Treasurer
Edward J. Retzinger . . . Secretary
Address of Secretary — Town Hall Rd. Beloit, Wisc.

St. Louis

Albert W. Zub . . . Chairman
William L. Gabbert . . . Vice-Chairman
John G. Hessburg . . . Vice-Chairman
Aircraft
Frank E. Pipe . . . Vice-Chairman
Diesel Engine
Robert G. Tuell . . . Vice-Chairman
Fuels and Lubricants
Harvey S. Gershenson Vice-Chairman
Parts and Accessories
James A. Jones . . . Vice-Chairman
Students
George Moore . . . Vice-Chairman
Transportation and Maintenance
Robert P. Lindeman . . . Treasurer
Gordon L. Scofield . . . Secretary
Address of Secretary — Missouri School of Mines & Metallurgy, Mech. Engrg. Dept., Rolla, Mo.

Salt Lake Group

Olonzo Adair . . . Chairman
Don A. Lawless . . . Vice-Chairman
John H. Coverdale Secretary-Treasurer
Address of Secretary-Treasurer — Continental Oil Co., Boxes 2250 & 2280, Salt Lake City, Utah

San Diego

W. W. Vyvyan . . . Chairman
Frank B. Tipton . . . Vice-Chairman
Floyd F. Rechlin . . . Treasurer
Henry W. Callihan . . . Secretary
Address of Secretary — 1245 Chalcedony, San Diego 9, Calif.

South Texas Group

Jack W. Richardson . . . Chairman
B. Chope Dial . . . Vice-Chairman
Robert E. Engelhardt . . . Treasurer
William P. Teich . . . Secretary
Address of Secretary — Auto. Res. Associates, 2901 Bandera Rd., San Antonio 1, Texas

Southern California

J. F. Beach . . . Chairman
H. E. Herdrich . . . Vice-Chairman
J. P. De Bree . . . Vice-Chairman
Aero-Space
J. C. Chiabotti . . . Vice-Chairman
Diesel Engine
L. P. Richardson . . . Vice-Chairman
Fuels and Lubricants
L. A. Lesovsky . . . Vice-Chairman
Passenger Car
John H. Shandorf . . . Vice-Chairman
Production
A. F. Schulze . . . Vice-Chairman
Transportation and Maintenance
G. W. Bowman . . . Vice-Chairman
Truck and Bus
M. K. Carter . . . Treasurer
Rudolph K. Polak . . . Secretary
Address of Secretary — Essick Mfg. Co., 1950 Santa Fe Ave., Los Angeles 21, Calif.

Southern New England

Arnold D. Nichols . . . Chairman
John H. Dittfach . . . Vice-Chairman
Walter J. Gewinner . . . Vice-Chairman
Aeronautics
Robert C. Olsen . . . Vice-Chairman
Bridgeport
W. E. Bancroft . . . Vice-Chairman
Engineering Materials
Donald Olson . . . Vice-Chairman
New Haven
Mark Goedecke . . . Vice-Chairman
Production
Robert Black . . . Vice-Chairman
Springfield
Waldemar Bischoff . . . Treasurer
John N. Humber . . . Secretary
Address of Secretary — American Bosch Division, American Bosch Arma Corp., 3664 Main St., Springfield, Mass.

Spokane-Intermountain

Gordon Schuster . . . Chairman
Hubert F. Randall . . . Vice-Chairman
Kenneth E. Nicholson . . . Treasurer
Lloyd Massender . . . Secretary
Address of Secretary — 6300 N. Forest Blvd. Spokane 15, Wash.

Syracuse

Richard A. Sturley . . . Chairman
Thurman O. Ruettinger Vice-Chairman
Youston Sekella . . . Vice-Chairman
Elmira
Howard J. Dingman . . . Vice-Chairman
Sidney
John G. Haig . . . Treasurer
Warren E. Biesemeyer . . . Secretary
Address of Secretary — Rollway Bearing Co., Inc., Sub., Lipe-Rollway Corp., 541 Seymour St., Syracuse 4, N. Y.

Texas

H. A. Helstrom, Jr. . . . Chairman
H. H. Edwards, Jr. . . . Vice-Chairman
D. H. Norton . . . Treasurer
W. M. Bludworth . . . Secretary
Address of Secretary — Temco Aircraft Corp., P. O. Box 6191, Dallas 22, Texas

Texas Gulf Coast

Leslie P. Graff . . . Chairman
Donald W. Wing . . . Vice-Chairman
Hugh Caughey . . . Vice-Chairman
Diesel Engine
Irving Pollock . . . Vice-Chairman
Fuels and Lubricants
Bill Fortenberry . . . Vice-Chairman
Production
Joe D. Little . . . Vice-Chairman
Transportation and Maintenance
A. C. Zugar . . . Vice-Chairman
Truck and Bus
John W. Kelley . . . Treasurer
Paul G. Anderson . . . Secretary
Address of Secretary — 8626 Pritchett Dr., Houston 35, Texas

Twin City

R. A. Hill . . . Chairman
Elmer D. Sowers . . . Vice-Chairman
J. J. Hite . . . Treasurer
J. B. McFail . . . Secretary
Address of Secretary — D. W. Onan & Sons, Inc., 2514 University Ave., S.E., Minneapolis 14, Minn.

Virginia

Robert P. Knighton . . . Chairman
Carroll S. Winn . . . Vice-Chairman
Charles W. Galloway . . . Treasurer
Eugene B. Sidoli, Jr. . . . Secretary
Address of Secretary — Bingham Truck Service, 107 W. Canal St., Richmond, Va.

Washington

I. W. Rhodes, Jr. . . . Chairman
Charles P. Hoffman, Jr. Vice-Chairman
J. M. Miller . . . Vice-Chairman
Aircraft
Walter Flinn, Jr. . . . Vice-Chairman
Transportation and Maintenance
Barry D. Boyce . . . Treasurer
Jordan E. Johnson . . . Secretary
Address of Secretary — 1707 Woodman Ave., Silver Spring, Md.

Western Michigan

William A. McLaurin . . . Chairman
Donald A. Paull . . . Vice-Chairman
William G. Jacobitz . . . Vice-Chairman
Grand Rapids
Calvin N. DeBruin . . . Treasurer
Morris V. Dadd . . . Secretary
Address of Secretary — 2532 White St., RFD 68, Muskegon, Mich.

Wichita

Kenneth W. Rix . . . Chairman
Harold J. Varhanik . . . Vice-Chairman
Gerald O. Deneau . . . Treasurer
Ralph W. Dagenais . . . Secretary
Address of Secretary — 1516 Pleasant View Dr., Wichita, Kan.

Williamsport Group

Donald A. Bernardi . . . Chairman
Bernard L. Sharon . . . Vice-Chairman
George R. Schramm . . . Treasurer
James C. Hughes . . . Secretary
Address of Secretary — Lycoming Division, AVCO Corp., Oliver St., Williamsport, Pa.

SAE's CEP News

COOPERATIVE ENGINEERING PROGRAM

Adamson Joins Technical Board

JOHN F. ADAMSON, chief engineer of American Motors' Automotive Division has joined the SAE Technical Board at the behest of Board Chairman A. A. Kucher. As a member of this group, he will help formulate policy for some 300 technical committees which constitute SAE's Cooperative Engineering Program. Each year these committees produce and up-date hundreds of standards, recommended practices, and information reports . . . which in turn save industry millions of dollars.

Adamson's American Motors' association began in 1947 when he joined Nash Research as a draftsman. He subsequently became a project engineer, assistant chief engineer, and assistant to the director of engineering. In 1959, he assumed his current post.

Adamson

New Checklist to Ease Maintenance

SAE Journal readers are being asked to comment on a service and accessibility checklist of maintenance features in construction equipment. The list was devised by the CIMTC Ease of Maintenance Subcommittee to remind design engineers of problems encountered by the man in the field. It will eventually be issued as a TR (Technical Report).

According to Subcommittee Chairman R. C. Navarin, "use of the report could prevent maintenance nightmares at little or no significant additional cost. Too often modifications have to be made to equipment to improve maintenance characteristics. As a result, the improvement costs two or three times the amount it would have cost if initially incorporated into the equipment.

"A number of companies have already included the material in the proposed report in handouts to their designers. Others have used it in posters."

Comments on the report shown below should be directed to:

R. C. Navarin
Engine Research and
Development Labs.
Mechanical Equipment Branch
Fort Belvoir, Va.

Standardization: (Examples: Fasteners, seals, bearings, pins, bushings, filters, filler caps, plugs, grease fittings)

- Is a minimum quantity used?
- Have you used a minimum of types or styles?

Continued on next page.

A service and accessibility checklist of maintenance features on construction equipment is being developed by the CIMTC Ease of Maintenance Subcommittee. (See story below) shown at a recent meeting in Chicago are (from left to right): J. A. Weber, H. V. Parsley, E. A. Kemp, Chairman R. C. Navarin, Co-Chairman L. S. Burns, A. G. Heisel, and W. P. Edwards.

New Checklist

. . . continued

- Are commercial replacements available?
- Will common mechanic's tools fit?

Accessibility:

- Are all maintenance points easily accessible?
- Can all components be easily checked, tested, or replaced?
- Have we made the most of unit assembly?
- Can these components be removed and assembled with a minimum of preliminary work?
- Are perishable items needing frequent or periodic replacement easy to service?
- Human Engineering Aspects—Are instruments and controls visible and accessible?

Lubrication:

- Are all moving parts adequately lubricated?
- Can lubrication points be reduced or grouped?
- Has a minimum number of lubricants been established?
- Can all oil level reading be obtained easily?
- Are adequate filters provided?

Safety:

- Personnel and Components
- Protection for servicing?
- Protection against lube and fuel oil drainage or spillage?

News from SAE Technical Committees

R. A. WILDE, Eaton Mfg. Co., will head a new subcommittee of the Iron and Steel Technical Committee's Division 33 — Gear Metallurgy. The new group hopes to develop uniform roller tests as a means of determining pitting and rolling fatigue of carburized gear materials.

EARL T. ANDREWS, Bendix-Westinghouse Automotive Air Brake Co., has been appointed chairman of the new Brake Subcommittee IX — Brake System Components which was created by the SAE Brake Committee last June. The group's initial responsibility will be for the existing SAE Air Brake Reservoir Test Code.

A. P. RASMUSSEN, Westinghouse Electric Corp., is the new chairman of the Contamination Control Panel of SAE Committee A-6, Aero-Space Hydraulic and Pneumatic Systems and Equipment. He succeeds M. P. Wolpin, Bell Aircraft Corp., who led the Panel during its development of a self-checking procedure for determining particulate contaminants (five microns or larger) in hydraulic fluids. The document was recently issued as ARP 598.

3 NEW AERO-SPACE FUEL SYSTEM GROUPS — SAE Committee AE-5, Aero-Space Fuel, Oil and Oxidizer Systems, has created three new panels to which standardization problems will be referred. Chairmen and areas of interest are:

K. R. BRAGG, chairman of the Fluid Systems Control Components Panel — responsible for valves, regulators, level control, flow and volume measurements, and filling equipment.

J. E. HICKS, chairman of the Fluid Systems Static Components Panel — responsible for couplings, filtration, heat exchangers, and fuel cells.

EARLE JOHNSON, chairman of the Fluid Systems Design and Testing Panel — responsible for systems design and testing philosophy as well as general criteria for fluid characteristics and standardization of fluid systems, design analysis and drafting practices.

Guideposts Issued to Technical Committees

"TECHNICAL Committee Guideposts," a new booklet recently distributed to those who participate in the Cooperative Engineering Program, is a statement of SAE policies and traditions which have emerged from years of successful technical committee operation.

The booklet positions the work of Technical Board groups in the context of overall SAE objectives. Also described are:

- Technical Board structure.
- Practical aspects of technical committee operation.
- Duties of technical committee chairmen.

One section, titled "How to Prepare Good SAE Technical Committee Reports", is aimed at members of *ground vehicle* groups. It defines, classifies, and gives legal requirements for SAE technical reports. It also tells how to prepare manuscript illustrations.

54 New

FIFTY-FOUR new documents have been added to SAE's family of Aeronautical Material Specifications. Their issuance in June was tied to the revision of 24 existing AMSs.

A complete set of the new and revised AMSs is available in loose-leaf form to supplement those previously issued. Each set, along with a revised AMS Index, may be obtained from SAE Headquarters for $14.

New Reports

AMS 2204 — Tolerances, Aluminum Rolled or Extruded Standard Structural Shapes

AMS 2417 — Nickel-Zinc Alloy Plating

AMS 2550 — Treatment of Sheet Metal Parts, Steel, Corrosion Resistant

AMS 2630 — Ultrasonic Inspection

AMS 2673 — Aluminum Molten Flux (Dip) Brazing

AMS 3415 — Flux, Aluminum Dip Brazing, 1030 F Fusion Point

AMS 3416 — Flux, Aluminum Dip Brazing, 1090 F Fusion Point

AMS 3633 — Plastic Tubing, Electrical Insulation, Irradiated Polyolefin, Heat Shrinkable

AMS 3780 — Copper Wire, Polytetrafluoroethylene Covered, Miniature

AMS 4024 — Aluminum Alloy Plate, 4.3Zn-3.3Mg-0.6Cu-0.2Mn-0.17Cr (7079-T651), Stress-Relief Stretched

AMS 4033 — Aluminum Alloy Plate, 4.5Cu-1.5Mg-0.6Mn (2024-T351), Stress-Relief Stretched

AMS 4034 — Aluminum Alloy Plate, Alclad, 4.5Cu-1.5Mg-0.6Mn (Alclad 2024-T351), Stress-Relief Stretched

AMS 4038 — Aluminum Alloy Plate, 5.6Zn-2.5Mg-1.6Cu-0.3Cr (7075-T651) Stress-Relief Stretched

AMS 4039 — Aluminum Alloy Plate, Alclad, 5.6Zn-2.5Mg-1.6Cu-0.3Cr (Alclad 7075-T651), Stress-Relief Stretched

AMS 4116 — Aluminum Alloy Bars, Rolled, 1Mg-0.6Si-0.3Cu-0.25Cr (6061-T4)

AMS 4119 — Aluminum Alloy Bars, Rolled, 4.5Cu-1.5Mg-0.6Mn (2024-T3510), Stress-Relief Stretched

AMS 4123 — Aluminum Alloy Bars, Rolled, 5.6Zn-2.5Mg-1.6Cu-0.3Cr (7075-

AMSs Swell Total to 958

T6510) Stress-Relief Stretched

AMS 4146 — Aluminum Alloy Forgings, 1Mg-0.6Si-0.3Cu-0.25Cr (6061-T4)

AMS 4164 — Aluminum Alloy Extrusions, 4.5Cu-1.5Mg-0.6Mn (2024-T3510), Stress-Relief Stretched, Unstraightened

AMS 4165 — Aluminum Alloy Extrusions, 4.5Cu-1.5Mg-0.6Mn (2024-T3511), Stress-Relief Stretched and Straightened

AMS 4168 — Aluminum Alloy Extrusions, 5.6Zn-2.5Mg-1.6Cu-0.3Cr (7075-T6510), Stress-Relief Stretched, Unstraightened

AMS 4169 — Aluminum Alloy Extrusions, 5.6Zn-2.5Mg-1.6Cu-0.3Cr (7075-T6511), Stress-Relief Stretched and Straightened

AMS 4389 — Magnesium Alloy Extrusions, 3Th-1.5Mn (HM31A-T5), Precipitation Heat Treated

AMS 4483 — Magnesium Alloy Castings, Permanent Mold, 10A1 (AM100A-T6), Solution and Precipitation Treated

AMS 4779 — Brazing Alloy, Nickel Base, 3.5Si-1.8B

AMS 5384 — Alloy Castings, Investment, Corrosion and Heat Resistant, Nickel Base, 18Cr-18Co-3Ti-3A1-4Mo-2Fe, Vacuum Melted and Cast, Solution and Precipitation Treated

AMS 5391 — Alloy Castings, Investment, Corrosion and Heat Resistant, Nickel Base, 13Cr-4.5Mo-0.75Ti-6A1-2.3(Cb+Ta), Vacuum Melted

AMS 5396 — Alloy Castings, Investment, Corrosion and Heat Resistant, Nickel Base, 28Mo-5Fe-0.4V

AMS 5543 — Steel Sheet and Strip, Corrosion and Heat Resistant, 13.5Cr-26Ni-1.75MO-3Ti, Vacuum Melted, Solution Treated.

AMS 5550 — Alloy Sheet and Strip, Corrosion and Heat Resistant, Nickel Base, 15.5Cr-3.25A1-0.75Ti

AMS 5551 — Alloy Sheet and Strip, Corrosion and Heat Resistant, Nickel Base, 19Cr-10Co-10Mo-1Al-2.5Ti, Vacuum Melted, Solution Heat Treated

AMS 5552 — Alloy Sheet and Strip, Corrosion and Heat Resistant, Iron Base-20.5Cr-32Ni-1.1Ti

AMS 5657 — Steel, Corrosion and Moderate Heat Resistant, 15Cr-7Ni-2.5Mo-1.1A1

AMS 5712 — Alloy, Corrosion and Heat Resistant, Nickel Base, 19Cr-11Co-10Mo-3Ti-1.5Al, Vacuum Melted, Solution Treated

AMS 5713 — Alloy, Corrosion and Heat Resistance, Nickel Base, 19Cr-11Co-10Mo-3Ti-1.5Al, Vacuum Melted, Solution and Precipitation Treated

AMS 5746 — Alloy, Corrosion and Heat Resistant, 15Cr-45Ni-4W-4Mo-3Ti-1Al, Consumable Electrode Vacuum Melted

AMS 5751 — Alloy, Corrosion and Heat Resistant, Nickel Base, 18Cr-17Co-3Ti-3Al-4Mo-4Fe, Vacuum Melted, Solution, Stabilization, and Precipitation Treated

AMS 5756 — Alloy, Corrosion and Heat Resistant, Nickel Base, 19Cr-10Co-10Mo-1Al-2.5Ti, Vacuum Melted, Solution Treated

AMS 5757 — Alloy, Corrosion and Heat Resistant, Nickel Base, 19Cr-10Co-10Mo-1Al-2.5Ti, Vacuum Melted, Solution and Precipitation Treated

AMS 5769 — Alloy, Corrosion and Heat Resistant, Iron Base, 20Cr-20Ni-20Co-3Mo-2W-1(Cb+Ta), Solution Treated

AMS 6265 — Steel, Premium Quality, 3.25Ni-1.2Cr-0.1Mo (0.07–0.13C) (SAE 9310), Consumable Electrode Vacuum Melted

AMS 6276 — Steel, Premium Quality, 0.55Ni-0.5Cr-0.2Mo (0.18–0.23C) (SAE 8620), Consumable Electrode Vacuum Melted

AMS 6406 — Steel, Sheet and Strip, 2.1Cr-1.6Si-0.55Mo-0.05V (0.41–0.46C)

AMS 6429 — Steel, 1.8Ni-0.8Cr-0.35Mo-0.2V (0.33–0.38C), Vacuum Melted

AMS 6435 — Steel Sheet and Strip, 1.8Ni-0.8Cr-0.35Mo-0.2V (0.33–0.38C), Vacuum Melted

AMS 6444 — Steel, Premium Bearing Quality, 1.45Cr (0.95–1.10C) (SAE 52100) Consumable Electrode Vacuum Melted

AMS 6458 — Steel, Wire, Welding, 1.25Cr-0.65Si-0.50Mo-0.30V (0.28–0.33C) Vacuum Melted

AMS 6462 — Steel Wire, Welding, 0.95Cr-0.2V (0.28–0.33C) SAE 6130

AMS 7458 — Studs, Steel, Low Alloy Heat Resistant, Normalized and Tempered-Roll Threaded

AMS 7460 — Bolts and Screws, Titanium Alloy, Heat Treated-Roll Threaded

AMS 7481 — Studs, Steel, Corrosion and Heat Resistant, Heat Treated-Roll Threaded

AMS 7849 — Tantalum Sheet and Strip

AMS 7850 — Columbium Sheet and Strip

AMS 7899 — Tungsten Sheet and Strip

Revised Reports

AMS 2201D — Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire and Forging Stock, Rolled or Drawn

AMS 2202C — Tolerances, Aluminum and Magnesium Alloy Sheet and Plate

AMS 2203D — Tolerances, Aluminum Alloy Drawn Tubing

AMS 2205D — Tolerances, Aluminum and Magnesium Alloy Extrusions

AMS 2243C — Tolerances, Corrosion and Heat Resistant Steel Tubing

AMS 2261D — Tolerances, Nickel, Nickel Base, and Cobalt Base Alloy Bars and Forging Stock

AMS 2412C — Silver Plating, Copper Strike-Low Bake

AMS 2815A — Identification and Packaging, Welding Wire

AMS 3635A — Plastic Sheet, Cellular, Shock Absorbing (Closed Cell, Foamed, Modified Vinyl Sheet)

AMS 3940C — Fibreboard, Hard Pressed, Structural

AMS 4037E — Aluminum Alloy Sheet and Plate, 4.5Cu-1.5Mg-0.6Mn (2024; -T3 Sheet, -T4 Plate)

AMS 4445A — Magnesium Alloy Castings, Sand, 3.3Th-0.8Zr (HK31A-T6), Solution and Precipitation Treated.

AMS 4778A — Brazing Alloy, Nickel Base, 4.5Si-2.9B

AMS 4890A — Copper-Beryllium Alloy Castings, Investment, 2Be-0.4Co-0.3Si

AMS 5355A — Steel Castings, Investment, Corrosion Resistant, 16Cr-4Ni-3.1Cu

AMS 5647A — Steel, Corrosion Resistant, 18Cr-8Ni (304L)

AMS 5665E — Alloy, Corrosion and Heat Resistant, Nickel Base, 15.5Cr-8Fe

AMS 5728B —— Steel Forgings, Corrosion and Heat Resistant, 16Cr-25Ni-6Mo, Hopkins Electric Ingot Process

AMS 5754B — Alloy, Corrosion and Heat Resistant, Nickel Base, 22Cr-1.5Co-9Mo-0.6W-18.5Fe

AMS 5768D — Alloy, Corrosion and Heat Resistant, Iron Base, 20Cr-20Ni-20Co-3Mo-2W-1(Cb+Ta), Solution and Precipitation Heat Treated

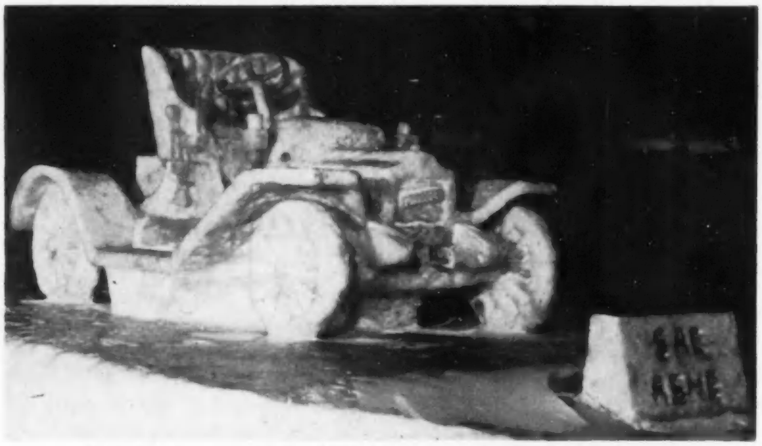
AMS 6355F — Steel Sheet and Strip, 0.55Ni-0.5Cr-0.2Mo (0.28–0.33C) (SAE 8630)

AMS 6407A — Steel, 1.2Cr-2Ni-0.45Mo (0.27–0.33C)

AMS 6461A — Steel Wire, Welding, 0.95Cr-0.2V (0.28–0.33C) SAE 6130, Vacuum Melted

AMS 7473B — Bolts and Screws, Roll Threaded

SAE at Michigan Tech



SAE, ASME's joint entry in Tech's 1959 Winter Carnival Snow Statue Contest.

Alternating Faculty Advisors

Niemi

E. W. NIEMI and **RICHARD BAYER** have alternated as faculty advisors for Michigan Tech's SAE Student Branch since it was established in 1952. Both men are graduates of the College and are registered professional engineers in Michigan.

Prof. Niemi is currently the acting advisor. He graduated from Michigan Tech in 1938 and went to graduate school at Michigan Tech, University of Michigan, and Stevens Institute.

After industrial experience at LeRoi Co., Milwaukee, and at the Allison Division of General Motors Corp., Niemi joined the faculty at Michigan Tech in 1941. He is currently associate professor of mechanical engineering.

Bayer

Niemi returned to Allison Division for summer employment in 1955 and has had experience doing consulting work in automotive engineering.

Prof. Bayer, who acts as co-advisor, graduated from Michigan Tech in 1944 and received his masters degree in 1954. He served in the U. S. Army Engineers Corps during World War II, and at the end of the war returned to Tech for graduate study. He joined the staff in 1947 and is presently associate professor, mechanical engineering.

Bayer has also done consulting work in automotive engineering, and has been employed for a summer at General Motors Research.

THOUSANDS of visitors are attracted to the biennial Engineering Show held at Michigan College of Mining & Technology . . . and to the displays prepared by SAE Student Branch which are a prominent part of the event. These displays compose only a small part of the many assorted activities of the nine year old Student Branch. In addition to holding a large number of interesting and worthwhile meetings the Branch contributes to the school's Winter Carnival, and hopes to establish a "workshop laboratory."

The Branch has made its largest contribution to the University's biennial Engineering Show by initiating the Automobile Show which is held in conjunction with the Engineering Show. The Automobile Show includes sports cars and stock automobiles, as well as a large number of operational displays set up by the SAE Branch.

Some of these displays include:

(1) An operating automobile chassis with necessary instrumentation to test reaction timing of the show visitors.

(2) Demonstrations showing the use of Cathode-ray Oscilloscope and Pressure Pick-up for engine evaluation.

(3) Operating demonstrations of various jet propulsion devices.

(4) Demonstrations showing engine performance using various fuels, including LP gas, on a laboratory engine.

(5) And, demonstrations showing basic engine testing, with large scale simplified instrument dials calibrated for the layman to read.

An engineering flavor is added to the School's "big" social event, the Winter Carnival, through the snow sculptures prepared by SAE Enrolled Students. These intricate and detailed sculptures usually represent an important event in the history of automotive engineering, such as the early model car (pictured above) contributed to last year's Carnival.

Aside from preparing displays and

carving snow sculptures, the Branch Members are aiming toward development of a more practical project—the establishment and equipping of a workshop laboratory for the servicing, testing and repairing of student automobiles. The idea for such a laboratory, initiated several years ago by a group of SAE Enrolled Students, includes construction of a two-stall garage with service pit on campus for use by any student who works on his own car. The project, however, has been temporarily halted due to financial difficulties, although the plan received favorable reaction fro mthe college administration.

The Branch's forty-plus members take care to maintain worthwhile, informative meetings by asking guest speakers who are prominent members of the automotive engineering field. Some of their more recent speakers include: W. J. Lux of Caterpillar Tractor Co.; F. B. Esty of Wisconsin Motor Corp.; Nelson Kunz of Buick Division, General Motors Corp.; G. J. Andreini of Pratt & Whitney Co., Inc.; R. J. Petersdorf of Wisconsin Electric Power Co.; and T. A. Boyd, formerly of General Motors Corp. and now retired.

The members also take an active part in Branch meetings by participating in student discussions. A recent meeting featured a panel discussion of the new compact cars and included a display of some of the 1960 models.

This very active Student Branch was first organized in January 1951 under the leadership of Prof. Edwin W. Niemi of the mechanical engineering department. Fred Kneisler — a current SAE member — served as the club's first chairman, and Prof. Niemi was faculty adviser. In April 1952, the club received its charter and became a full-fledged Student Branch. Since then Prof. Niemi and Prof. Richard Bayer have alternated as faculty advisors.

During 1959–1960 Paul Mahoney from Ishpeming, Mich. and Jack Thorn from Wyandotte, Mich. shared chairmanship of the Branch. Ed Goulet from Muskegon was vice-chairman; and George DeRoch and Pat Gleason from Ishpeming served as secretaries.

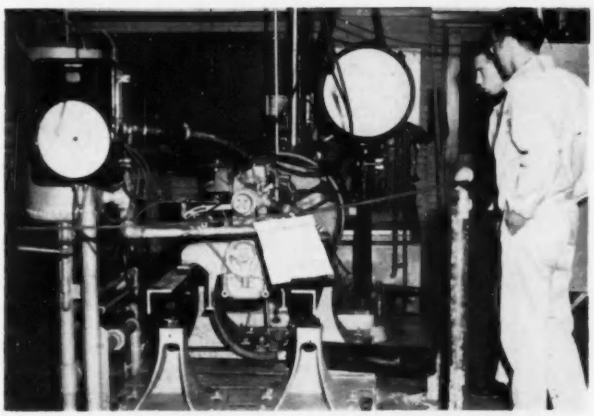
Now celebrating its seventy-fifth anniversary of founding, Michigan Tech was mainly a college of mineral technology until 1927, when it added all major fields of engineering and science to its curricula. Today it grants degrees in ten fields of engineering: Chemical Engineering, Civil Engineering, Electrical Engineering, Engineering Administration, Mining Engineering, Engineering Physics, Geological Engineering, Geophysical Engineering, Mechanical Engineering, and Metallurgical Engineering. Over 600 students are enrolled in Mechanical Engineering. About 120 have, or will by their sr yr, select the automotive option.

Among the prominent SAE members who are Michigan Tech alumni are SAE Membership Chairman W. J. Lux and W. A. Turunen.

Tech's East Campus (above), which includes 71 acres overlooking St. Mary's River and the city of Sault Ste. Marie, Ont., offers the first year of Mining or Metallurgical Engineering and two years of all other curricula. (Tech's 645-acre main campus is located in Houghton, Mich. along Portage Lake.)

Tech's 1959 Engineering Show

Operational model rocket engine entered by the Michigan Tech Rocket Society.



Demonstration of Dynanometer test-I.C. engine entered by SAE Student Branch.

SAE MEMBERS


Roeder


Heinemann


Findeisen


Mamrol

SAE PAST - PRESIDENT DALE ROEDER has been appointed chief engineer for Ford Motor Co.'s military vehicles operation — defense products group. He will direct engineering on all military vehicles developed and built for the Department of Defense. He recently headed the engineering team that designed and built Ford's new version of a medium military tactical truck that can transport troops and cargo over water as well as land.

EDWARD H. HEINEMANN has been appointed executive vice-president of Summers Gyroscope Co. He had been vice-president of Douglas Aircraft Co. in charge of combat aircraft engineering, aircraft, and missiles.

JOHN O. FINDEISEN, JR., has been named executive vice-president of Park Products Co. He assumes his new position after 17 years with Thompson-Ramo-Wooldridge, Inc. He was most recently contract administrator for the Tapco Group.

FRANK E. MAMROL has been appointed chief engineer of Paisecki Aircraft Corp., Philadelphia. Formerly chief of design and chief project engine, Mamrol directed the Paisecki "Sky Car" Aerial Jeep project.

RONALD E. DENNIS has become research engineer for Caterpillar Tractor Co. Formerly he was engineering technician.

ROBERT W. PODLESAK has been named manager of Chevrolet Motor Division's 21 manufacturing plants across the nation. Previously he was regional plant manager for General Motors Corp. in charge of Chevrolet's manufacturing plants at Flint, Saginaw, and Bay City, Mich.

C. L. SCHNEIDER, president of Highway Trailer Industries, Inc., has provided for a $3,000 scholarship to cover a full four year course in motor transport management at Tri-State College.

Schneider has been associated with the special course since the original plans were drawn up in 1956. The four year program, which leads to a bachelor of science degree, was established and developed in close cooperation with the National Committee on Education of American Trucking Associations. It is designed to train men for administrative and supervisory positions in the motor transport industry.

JOHN P. GATY, vice-president, general manager, and a director of Beech Aircraft Corp., has announced his resignation which will be effective at the corporation's fiscal year end, Sept. 30.

He will devote his full time in the future to various personal business interests.

CHARLES S. WAGNER has been named assistant general manager of Lockheed Aircraft Corp.'s Georgia Division. He succeeds **H. Fletcher Brown**, who was appointed vice-president of Lockheed Aircraft Service.

Wagner has been executive assistant to the executive vice-president of Lockheed since May 1959.

ROBERT F. BLACK, chairman of the board of White Motor Co., recently celebrated his 25th anniversary with White Motor Co. and his 50th year in the industry.

K. G. MATTHEWS has become development engineer, engine, at Willys Motors, Inc. Previously he served Ford Motor Co. as unit supervisor, product study vehicles. (In the July SAE Jour-

nal, K. G. Matthews was erroneously referred to as K. G. Williams.)

WILLIAM L. MOSHER, JR., succeeds **Dale D. Douglass** as regional plant manager of Chevrolet assembly plants in Western U. S. Previously he served General Motors Corp. as manager of Chevrolet plants in Detroit, and Buffalo, Tonawanda, and Massena, N. J.

MORRIS R. MORROW is serving Esso Research & Engineering Co. as section head at their Products Research Division. He is on a leave of absence from Humble Oil & Refining Co., a subsidiary of Esso, where he has been employed as research section head.

JOHN P. KLOCKSIEM has been appointed staff engineer for satellite systems vehicle development at Missiles & Space Division of Lockheed Aircraft Corp. Formerly he was chief design engineer for Hughes Tool Co., Aircraft Division.

DR. ERWIN A. V. HORIAK has joined the faculty of Indiana Technical College as an associate professor. While teaching at the college he will also serve as engineering consultant to International Harvester Co., Motor Truck Engineering Department.

Horiak was previously director of engineering for Hercules Motors Corp.

ARTHUR G. BAITZ has been appointed to the new post of director of engineering planning for Robertshaw-Fulton Controls Co. with headquarters in Richmond, Va. Previously he was director of sales training at the company's Fulton Sylphon Division in Knoxville, Tenn.

C. E. STRYKER has retired as west coast representative, systems development section Bendix Products Division, Bendix Corp. He has joined U. S. Divers as an engineering consultant. He plans to spend his spare time building a house in the mountains where he will eventually live.

GEORGE T. BROWN has been named staff engineer in charge of field service modifications and special attachments design for Shanahan Equipment Corp. Previously he was superintendent of maintenance and equipment for Universal Leaseway Systems, Inc. of Massachusetts.

Brown has served in various capacities on SAE New England Section's governing board and is chairman of the Section for 1960-1961.

J. A. KEMP has retired as chief designer for Albion Motors, Ltd., Glasgow, Scotland. He will retain his position as a director of the company, and will continue to serve the company as a technical consultant.

Breech Resigns as Ford Motor Chairman

ERNEST BREECH has resigned as chairman of Ford Motor Co. and **HENRY FORD II**, president, has taken over as chairman. Ford will keep both president and chairman titles.

Breech will remain as a member of the Board of Directors and was given the newly created job of chairman of the company's finance committee.

Breech

GORDON SWARDENSKI has been appointed director of manufacturing for domestic operations at Caterpillar Tractor Co. He had been manager of the company's Peoria plant since 1957.

ANDREW C. LYON has been elected a vice-president of Standard Products Co., assigned to the company's Detroit Sales Office. Previously he was vice-president and general manager of Standard Products, Ltd. in Ontario.

DAVID O. PARK has become associate engineer for AMF Atomics. Previously he was service engineer for Combustion Engineer, Inc.

ALLAN G. SHEPPARD has retired as vice-president in charge of engineering and development for American LaFrance Division of Sterling Precision Co., Elmira, N. Y.

Sheppard is now owner and operator

continued

RPI Honors S. E. Skinner

Skinner

S. E. SKINNER, executive vice-president and a director of General Motors Corp., has been elected a life trustee of Rensselaer Polytechnic Institute.

A 1920 graduate of RPI, Skinner has served previously on the board of trustees. He has been a leader in the Alumni Association, and a member of the Corporation and Science Building committees of the Institute's Development Council.

He was awarded an honorary doctor of engineering degree by Rensselaer on June 10. The citation reads, "Yours has been a straightforward progress up the stepping stones of increasing corporative responsibility. But on your way you have found time to serve the nation in war, your neighbors and your profession in peacetime and your alma mater whenever you were called upon to do so. You have enriched Rensselaer by your counsel and service and you have added luster to its tradition."

STEPHEN JOHNSON, JR. was recently elected vice-president of Bendix-Westinghouse Automotive Air Brake Co. He will continue to serve as general manager of the company's Air Brake Division in Elyria, Ohio, and will retain responsibility for operation of their branch plants in Berkeley, Calif. and Oklahoma City.

A 37 year veteran of the company, Johnson was one of the original group of engineers who pioneered air brakes for automotive vehicles and participated in the installation of the first air brake compressor for the power braking of a bus in 1923. He has been granted numerous patents on air brake devices and has contributed many papers to technical group meetings and journals.

An active member of SAE, Johnson was a Director of the Society in 1937 and in 1947.

(Continued from preceding page)

of Sage-n-Sand resort motel on Boynton Beach, Fla. The motel is being managed by his son.

CHARLES W. BOHMER, JR., previously manager of industrial and consumer sales for Esso Standard Division of Humble Oil & Refining Co., has joined the company's headquarters staff in Houston.

In his new post, he will serve as assistant in marketing matters to the vice-president and director of marketing.

DR. RODERICK S. SPINDT, head of combustion research section, Automotive Engineering Division, Gulf Research & Development Co., has prepared three articles on combustion for the forthcoming McGraw-Hill Encyclopedia of Science and Technology. His contributions, dealing with measurement techniques, include an 800 word article on burning velocity measurement, a 400 word item on combustion wave measurement, and a 400 word article on spectroscopy of combustion.

FREDERICK P. GLAZIER has joined Sun Oil Co. as special assistant in the Research and Development Division. In this capacity, he will be the principal liaison for Sun Oil with the automotive and aviation industries.

Prior to joining Sun, Glazier was in succession a technical representative for Texaco, Inc., chief project engineer for Wright Aero Division of Curtiss-Wright Corp. and vice-president of sales and research for Laboratory Equipment Corp.

EDWARD D. KANE has been appointed sales manager of Kahn & Co., Inc. Prior to joining Kahn & Co. he was divisional sales manager of Cuno Engineering Corp.

Kane has been a consultant to the Atomic Energy Commission doing work on submarine reactors and the first atomic generating station. His previous experience also includes works as a design process engineer for Ontario Paper Co., Ltd., and as a rocket test engineer for Bell Aircraft Co.

IRVING WHITEHOUSE has been appointed director of research for Republic Steel Corp. He succeeds the late **Earle C. Smith.**

Whitehouse joined Republic in 1935 as a sales engineer for the Steel and Tubes Division. He was made manager of the company's Process and Product Development Division in 1940 and became assistant director of research in 1958.

H. J. URBACH, formerly executive engineer, has been named director of engineering for Timken Roller Bearing Co.

Urbach joined Timken's railway engineering department in 1933. Subsequently he became design and service engineer for diesel fuel injection department, mechanical engineer for special projects, and works engineer. In 1951 he was named executive engineer.

RALPH E. McKELVEY, formerly assistant chief engineer of Timken's physical laboratories, has been named assistant director of engineering for Timken Roller Bearing Co.

McKelvey joined Timken in 1948 as test engineer in the physical laboratory. He became project engineer in 1953, and was named assistant chief engineer in 1959.

DR. R. W. CHAPMAN, JR. has been appointed manager of product development and technical services for marketing department of The Atlantic Refining Co. He succeeds **Dr. J. C. Geniesse,** who recently retired after 35 years of service with the company.

Chapman joined Atlantic in 1950 and has been associated with research and development department. His most recent position was director of analytical section.

DALE D. DOUGLASS has become regional plant manager in charge of Chevrolet assembly plants in Eastern U. S. Previously he served General Motors Corp. in a similar capacity for Chevrolet plants in Western U. S.

C. E. McTAVISH, since 1951 president of Perfect Circle Co., Ltd., Ont., has retired from the presidency and has been elected chairman of the board.

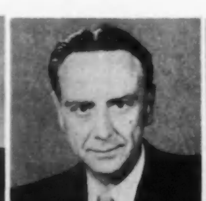
Bohmer

Spindt

Glazier

Kane

Whitehouse



Urbach

McKelvey

Chapman

AUGUST J. HOFWEBER, JR. has been appointed director of reliability to head the newly established product reliability department at Ternstedt Division of General Motors Corp. He had been staff engineer in Ternstedt's product engineering department since May, 1959.

W. BLAKE DODDS, formerly vice-president and general manager of Perfect Circle Co., Ltd., has been elected president and general manager, succeeding **C. E. McTavish.**

CARL A. KENNINGER has become transmission project engineer for Spring Division of Borg-Warner Corp. Previously he was resident engineer for Chrysler Corp.

HERBERT W. BEST has retired as associate professor of mechanical engineering at Yale University. Best is recognized as a specialist on engine-fuel relationships.

LESTER C. LICHTY has retired as professor of mechanical engineering at Yale University. Lichty is the author of a number of technical books on internal combustion engines.

HERBERT CHASE was a winning contestant recently is a unique tennis doubles match. The single rule was that the combined ages of each team must total 150 years. The team of which Chase, 75, was a member totaled 154 years; so did their opponents, also with a 75 and 79 combination. The match took place at the famous West Side Tennis Club at Forest Hills, L. I., N. Y. . . . and Chase's team won 3-6, 6-3, 6-4. Chase has been a member of SAE for more than 50 years, and of the West Side Tennis Club for almost as long.

F. J. EAMES has become deputy chief engineer for U. K. Co. of Massey-Ferguson S. A. with headquarters in Coventy, England. Previously he was director of engineering for Massey-Ferguson in Paris.

H. P. BROWN has become service representative for Central America with headquarters in Camino Toluca, Mexico, for Cummins Diesel International, Ltd. Previously he was field representative in Columbus, Ind. for Cummins Engine Co.

CHARLES S. WAGNER is assistant general manager, Lockheed Aircraft Corp., Georgia Division, Marietta, Ga. He had been executive assistant to the executive vice-president of Lockheed, at Burbank, Calif.

American Airlines Promotes . . .

Lawrence

WILLIAM C. LAWRENCE has been named vice-president of American Airlines in charge of its recently formed Development Engineering Department. Previously an assistant vice-president in charge of American's Engineering Department, Lawrence will have three branches under his direction in the new Development Engineering Department: (1) Engineering Research and Development, (2) Safety, and (3) Aircraft Development. Lawrence is a Past SAE Director and is currently a member of the Aero-Space Council of the SAE Technical Board.

Kolk

FRANK W. KOLK has been named an assistant vice-president, reporting to Lawrence. Directly in charge of the Engineering Research and Development Division, Kolk will be responsible for aircraft preliminary design, technical staff support related to new aircraft, research and development of systems and components, and general engineering staff support.

Beard

M. G. BEARD, continuing as assistant vice-president, heads up the Safety Division in the new Department.

Brink

GLENN H. BRINK heads up the Aircraft Development Division, which has as its function new aircraft management, aircraft factory representative offices, factory acceptance tests, and engineering research and development flight testing.

Obituaries

H. K. CUMMINGS . . . (M'27) . . . physicist, National Bureau of Standards, U. S. Department of Commerce . . . died May 13 . . . born 1888.

JOSEPH F. GETTRUST . . . (M'57) . . . sales manager, Nelson Muffler Corp. . . . died July 10 . . . born 1913.

CHARLES H. NORTH . . . (M'28) . . . retired . . . died June 10 . . . born 1894.

C. L. OHEIM . . . (M'56) . . . vice-president in charge of product development, Deere & Co. . . . died May 29 . . . born 1894.

ARNOLD A. RACKHAM . . . (M'56) . . . president of British & Continental Motor Sales, Ltd. . . . died May 4 . . . born 1919.

EARLE C. SMITH . . . (M'43) . . . chief metallurgist and director of research for Republic Steel Corp. . . . died May 20 . . . born 1891.

ANGUS G. STURROCK . . . (M'50) . . . manager of Metallurgical Division, Wyckoff Steel Co. . . . died July 1 . . . born 1901.

Among SAE Enrolled Students

. . . . . who have entered industry

JAMES T. ALBERT . . . University of Rochester . . . associate engineer, Kellogg Division, American Brake Shoe Co.

CHARLES J. ALMOND . . . Tri-State College . . . engineer trainee, Perfect Circle Corp.

HANSFORD ANDERSON . . . Northrop Institute of Technology . . . product maintenance engineer, The Martin Co.

PHILLIP G. ARNDT . . . Wayne State University . . . senior engineer, Vickers, Inc.

CHARLES A. ASHBY . . . Georgia Institute of Technology . . . industrial engineer, Chatham Electronic Division, Tung-Sol Electric, Inc.

HARRY A. J. ATKINS . . . General Motors Institute . . . process engineer, McKinnon Industries, Ltd., Subsidiary GMC

GARY A. BAGBY . . . Missouri School of Mines and Metallurgy . . . design engineer, Phillips Petroleum Co.

RICHARD F. G. BAKER . . . University of Toronto . . . production engineer, General Motors of Canada, Ltd.

THEODORE L. BAYLESS . . . Ohio State University . . . process engineer, Kimble Glass Co.

DONALD LEE BEERS . . . University of California . . . research engineer, California Research Corp.

DOUGLAS L. BLEDSOE . . . San Diego State College . . . associate engineer, Convair Astronautics

PHILLIP A. BOHM . . . California State Polytechnic College . . . design engineer, Lawrence Radiation Laboratory

STUART S. BOWER . . . University of Michigan . . . test engineer, International Harvester Co.

ROBERT R. BRESHEARS . . . University of California . . . development engineer, Jet Propulsion Laboratory

WILLIAM R. BROOKES . . . University of Saskatchewan . . . plant engineer, Regina Light & Power

WILL K. BROWN, JR. . . . University of Kentucky . . . instructor, Mechanical Engineering Dept., University of Kentucky

JEAN BRUNELLE . . . Ecole Polytechnique of Montreal University . . . mechanical engineer, Ralston & Purina

DALE F. BULLER . . . Purdue University . . . machine design, General Electric Co.

JOEL R. BUMPUS . . . Northrop Institute of Technology . . . A & P mechanic, Pan American World Airways, Inc.

JOHN A. CAHOON . . . Tri-State College . . . junior engineer, FWD Corp.

JACK W. CARTER . . . Bradley University . . . research engineer, Caterpillar Tractor Co.

CLIFTON J. CHANDLER . . . Northrop Institute of Technology . . . data reduction supervisor and problem analyst, Associated Aero Science Laboratories, Inc.

RICHARD J. CLARKE . . . University of Miami . . . powerplant engineer, American Airmotive Corp.

JAMES L. COULTER . . . General Motors Institute . . . student, General Motors Engineering Staff

DOUGLAS G. CULY . . . Oregon State University . . . junior engineer, Pratt & Whitney Aircraft

DONALD P. CUMMINS . . . University of Illinois . . . engineer trainee, Caterpillar Tractor Co.

ROBERT E. DART . . . University of Saskatchewan . . . engineer trainee, British American Oil Co., Ltd.

BRETT P. DE DUBE . . . Academy of Aeronautics . . . engineer, Missile Division, Republic Aviation Corp.

KEITH R. DEYO . . . Chrysler Institute of Engineering . . . engineer, Chrysler Corp.

H. S. DHINDSA . . . Madras Institute of Technology . . . sales supervisor, Standard-Vacuum Oil Co.

JEROME L. DORSTEN . . . General Motors Institute . . . junior engineer, Inland Mfg. Division, GMC

LARRY D. DUQUETTE . . . University of Pittsburgh . . . plant engineer, Duraloy

IRA R. EHRLICH . . . University of Michigan . . . mechanical engineer International Electric Corp.

JAMES B. FARROW, JR. . . . Northrop Institute of Technology . . . junior design drafting, Wyle Laboratories

ALAN R. FISHER . . . Chrysler Institute of Engineering . . . engineer, Engineering Division, Chrysler Corp.

RICHARD H. FLEMING . . . Purdue University . . . engineer — AED, Standard Oil Co.

THOMAS R. FORRESTER . . . University of Michigan . . . junior engineer, Cadillac Motor Car Division, GMC

WILLIAM S. FREAS . . . Case Institute of Technology . . . junior engineer, GMC

EDWIN N. FRIESEN . . . University of California . . . assistant plant engineer, Department of Water & Power, City of Los Angeles

REINHOLD L. GERBER . . . San Diego State College . . . design engineering, Oceanside Heating & Ventilating Co.

WAYNE J. GLAUSER . . . Utah State University . . . engineer, Martin-Denvel

EDWARD C. GRAHN . . . Illinois Institute of Technology . . . engineer, Danly Machine Specialities, Inc.

OSWALDO GUADA . . . Indiana Technical College . . . junior engineer, Cartones Nacionales S. A.

VERNELL M. HANCE . . . University of Washington . . . research engineer, California Research Corp.

WILSON HOAG, JR. . . . Northrop Institute of Technology . . . Service Representative, Bell Helicopter Corp.

JOHN A. HOLMBERG . . . University of Washington . . . mechanical engineer, Guy F. Atkinson Co.

JESSE A. HONEYWELL . . . Northrop Institute of Technology . . . junior engineer, Wyle Laboratories

LEE C. HOPPE . . . Milwaukee School of Engineering . . . industrial salesman, Texaco, Inc.

ROBERT A. HORVATH . . . Fenn College . . . draftsman, Cleveland Form Grader Co.

RICHARD A. JANSSEN . . . Ohio State University . . . sales engineer, Standard Conveyor Co.

EARLING C. JOHNSON . . . Northrop Institute of Technology . . . engineer, Simpson Electric Co.

DONALD J. JUST . . . Carnegie Institute of Technology . . . test engine development engineer, International Harvester Co.

P. R. KEEN . . . Loughborough College of Technology . . . engineer, A. B. Volvo Co.

CARLISLE KING . . . University of Washington . . . associate engineer, Industrial Products Division, Boeing Airplane Co.

JAMES A. KRAUSE . . . Fenn College . . . industrial engineer, American Greeting Corp.

GERALD G. KRONINGER . . . Chrysler Institute of Engineering . . . engineer, Sun Oil Co.

LEONARD KUBE . . . Marquette University . . . research metallurgist, A. O. Smith Corp.

FREDERICK R. LANDIG . . . Ohio State University . . . design engineer, Central Ohio Welding Co., Inc.

JACK E. LARSON . . . University of Michigan . . . designer, Manning Maxwell & Moore

GEORGE F. LEONHARD . . . University of Washington . . . research engineer, Autonetics, Division of North American Aviation

JAMES M. LEWIS . . . Stevens Institute of Technology . . . test engineer, Mack Trucks, Inc.

TIM F. LEZOTTE . . . Michigan College of Mining & Technology . . . research engineer, Ford Motor Co.

HARRY T. LINDE . . . Northrop Institute of Technology . . . design engineer, Fruehauf Trailer Co.

GORDON J. LIS . . . Marquette University . . . research engineer, Bostrom Corp.

JERRY A. LUPTON . . . Purdue University . . . junior plant layout engineer, Chevrolet-Livonia Plant, Division of GMC

FRANKLIN D. MADDOX . . . University of Cincinnati . . . engineer, Rust Engineering Corp.

SAMUEL R. MAMI . . . Pennsylvania Military College . . . mechanical engineer, Naval Air Development Center

DANIEL J. MANEELY . . . University of California . . . engineer, United Technology Corp.

PAUL F. MARSHALL . . . University of Wisconsin . . . junior engineer, Fairbanks-Morse & Co.

BILL J. MARTIN . . . Purdue University . . . design engineer, International Harvester Co.

SAMUEL A. MAZZOLA, JR. . . . University of Michigan . . . product development engineer, Ford Motor Co.

ROBERT L. McNABB . . . University of Illinois . . . junior engineer, Caterpillar Tractor Co.

HARDARSHAN SINGH MEJIE . . . University of Illinois . . . associate prof., Guru Nanak Engineering College

JOHN F. MELAUGH, JR. . . . Oklahoma State University . . . associate engineer, Boeing Airplane Co.

PAUL E. MERRIMAN . . . Indiana Technical College . . . test engineer, International Harvester Co.

ROGER A. MICHAELS . . . Academy of Aeronautics . . . instructor, La Guardia Airport

RONALD L. MILLER . . . Missouri School of Mines & Metallurgy . . . design engineer, Phillips Petroleum Co.

BERT J. MINSHALL . . . University of Wisconsin . . . junior engineer, AiResearch Mfg. Co. of Arizona

JAMES C. MOCK . . . General Motors Institute . . . process engineer, Fisher Body Division, GMC

LOUIS MORIN . . . Ecole Polytechnique of Montreal University . . . sales trainee, Shell Oil Co. of Canada, Ltd.

JOHN E. MORLOCK . . . Missouri School of Mines & Metallurgy . . . methods, Buick Motor Division

WILLIAM J. MOSES . . . Missouri School of Mines & Metallurgy . . . sales engineer, Federal Pacific Electric Co.

WILLIAM C. NEAL . . . Northrop Institute of Technology . . . associate development engineer, The Marquardt Corp.

JOHN J. NELSON . . . Illinois Institute of Technology . . . design engineer, International Harvester Co.

ROBERT G. NELSON . . . Missouri School of Mines & Metallurgy . . . layout engineer, International Harvester Co.

ROBERT E. NETH . . . University of Illinois . . . graduate trainee, Ford Motor Co.

AKITO OGOSHI . . . Northrop Institute of Technology . . . shop mechanic, United Airlines, Inc.

MARIUS PAQUIN . . . Ecole Polytechnique of Montreal University . . . mechanical, Shawinigan Chemicals, Ltd.

LAWRENCE G. PECK . . . Lawrence Institute of Technology . . . junior designer, Fisher Body Division, GMC

HOWARD A. PENDERGRAST . . . Chrysler Institute of Engineering . . . automotive engineer, Chrysler Australia, Ltd.

ROBERT A. PETTINGILL . . . Milwaukee School of Engineering . . . junior tool engineer, Dynex, Inc.

RICHARD E. PFEIFER . . . Chrysler Institute of Engineering . . . test & development engineer, Chrysler Corp.

ERNEST L. PHELPS . . . Northrop Institute of Technology . . . service analyst, North American Aviation

WELDON L. PHELPS . . . Missouri School of Mines & Metallurgy . . . junior engineer, Caterpillar Tractor Co.

WILLIAM F. PIEPER . . . San Jose State College . . . test engineer, North American Aviation Autonetics

Continued on next page.

SAE Enrolled Students

. . . Enter Industry

EARLE S. PRESTEN . . . Oregon State College . . . design engineer, Power Brake Equipment Co.

RAYMOND C. RANDEL . . . Wayne State University . . . junior mechanical engineer, City of Detroit, Department of Streets & Traffic

GERALD E. RITCHEY . . . Bradley University . . . plant engineer, Anaconda Wire & Cable

PHILLIP J. RITCHIE . . . Tri-State College . . . mechanical engineer, Perfect Circle Corp.

JEROME C. ROSENWALD . . . Marquette University . . . junior engineer, Bendix Products Division, Bendix Corp.

DON D. SAMPSON . . . San Jose State College . . . field engineer, Autonetics Division, North American Aviation, Inc.

JAMES R. SANTANGELO . . . Parks College . . . student, Parks College of Aeronautical Technology

JOHN R. SAVAGE . . . University of Cincinnati . . . junior service engineer, Delco Products Division, GMC

RICHARD P. SCHAEFFER . . . Purdue University . . . engineer, Ohio Oil Co.

DONALD J. SCHRAGE . . . Milwaukee School of Engineering . . . engineer trainee, Surface Combustion Division, Midland Ross Corp.

M. S. SEETHARAMAN . . . Madras Institute of Technology . . . section officer, Neyveli Lignite Corp.

BILL D. SEVIER . . . Agricultural and Mechanical College of Texas . . . associate engineer, Convair — Astronautics

D. S. SHAH . . . University of Illinois . . . junior engineer, Remington Rand Unival.

NALIN H. SHAH . . . University of Michigan . . . design and development engineer, Premier Automobiles, Ltd.

KEVIN SHEEHAN . . . New York University . . . senior engineer, Wright Aeronautical Division, Curtiss-Wright Corp.

RICHARD A. SIGERIST . . . Northrop Institute of Technology . . . A/C draftsman, Lehigh Design Co., Inc.

PHILIP E. SMITH . . . Purdue University . . . junior project engineer, Oldsmobile Division, GMC

JEROME T. SMUTEK . . . University of Detroit . . . college trainee, Lincoln Division, Ford Motor Co.

V. V. SRINIVASAN . . . Madras Institute of Technology . . . section officer, Neyveli Lignite Corp., Ltd.

DONALD C. STAAB . . . University of Wisconsin . . . design engineer, Minneapolis-Moline Co.

DOUGLAS STANYER . . . University of British Columbia . . . engineer trainee, Peter Kiewit Sons Company of Canada, Ltd.

WILLIAM C. STEELE, JR. . . . Tri-State College . . . application engineer, New Departure Division, GMC

MARLYN D. TANIS . . . University of Buffalo . . . assistant project engineer, Firewel Company, Inc.

JOE E. TAUCHER . . . University of Cincinnati . . . sales engineering, Cooper-Bessemer Corp.

DAVID L. TAYLOR . . . Marquette University . . . draftsman, Allis-Chalmers Mfg. Co., Inc.

FRANK G. TENKEL . . . University of Michigan . . . junior engineer, American Motors Corp.

JAMES O. TENNIES . . . Indiana Technical College . . . junior engineer, Morse Chain Co.

TERRY A. TETENS . . . Michigan State University . . . graduate engineer, General Motors Corp.

JEROME W. THOMPSON . . . Northrop Institute of Technology . . . draftsman, Parker Aircraft Co.

CHARLES H. TORNER . . . Marquette University . . . junior engineer, General Motors Technical Center — Styling

S. VAIDHESSWARAN . . . Madras Institute of Technology . . . partner, D. S. M. Transports

W. H. M. J. VANDER HORST . . . General Motors Institute . . . senior detailer, Chevrolet Motor Division, GMC

JOHN W. VAN WAY . . . Purdue University . . . engineer trainee, Cummins Engine Co.

WILLIAM S. WATSON . . . Oklahoma State University . . . engineer, technical writer, Eimco Corp.

HAROLD E. WENNINGER . . . Purdue University . . . mechanical engineer, Cooper-Bessemer Corp.

ROBERT J. WICKE . . . Agricultural and Mechanical College of Texas . . . staff member, Sandia Corp.

LINO F. WIDMANN . . . University of Michigan . . . automobiles, Ford Motor Co.

JON S. WILSON . . . Chrysler Institute of Engineering . . . senior test engineer, Chrysler Corp.

JOSEPH W. WISWALL . . . University of Illinois . . . research engineer, Caterpillar Tractor Co.

FRANKLIN H. WRIGHT, JR. . . . University of Illinois . . . engineer draftsman, International Harvester Co.

SAMI F. ZAWIDEH . . . Detroit Institute of Technology . . . test engineer, Long Mfg. Division, Borg Warner Corp.

JOHN A. ZIDAK, JR. . . . Tri-State College . . . product engineer, Saginaw Steering Gear Division, GMC

FRED A. ZIEGLER . . . University of Cincinnati . . . service engineer, Giddings & Lewis Tool Co.

GILBERT ZWEIG . . . New York University . . . junior engineer, Burroughs Corp.

1961 Engineering Graduates . . .

. . . who want to work in the industries served by the Society of Automotive Engineers, Inc.

For complete address, write: SAE Placement Service
485 Lexington Avenue
New York 17, N. Y.

Telephone:
OXford 7-3340

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
		ACADEMY OF AERONAUTICS
Open	R. B. Helbig A & P — March	Interested in res. & dev. of powerplants. Have diploma from Academy of Aeronautics in Airframe and Powerplant Technology and A & E license.
Open	J. B. Doherty A & P — April	A & P certificates, aircraft & powerplant technology was the course taken. Desire position in res. & dev. Further schooling intended.
Open	John Csady A & P — March	Will graduate with diploma in Airframe & Powerplant Technology with A & E license. Would like job dealing with res., dev. or testing of new design gas turbine or reciprocating engines.
Open	F. M. Covino A & P — March	Will graduate with diploma in Airframe & Powerplant Technology and A & E license. USA veteran. Licensed commercial pilot. Desire position in res., dev. or testing new design reciprocating or gas turbine engines.
Open	John Bombara A & P — March	Will have A & P mechanics license. Would like job leading to flight engineer.
New York	Albert Arnedos A & P — Feb.	Seek job with aircraft or auto. mfr. which might be first step in equipping me for responsible work as quality control engr.
		BRADLEY UNIVERSITY
U. S.	G. G. Maxwell BME — June	Am 27, married & a USAF veteran. Desire ME experience in auto. industry.
Open	Warren Zehr BSME — June	Desire engrg. sales leading to mgmt. responsibility. Experience: Service Supv. (3 yrs.), Territory Mgr. (2 yrs.), owner, mgr. of retail car, truck & farm equipment business (8 yrs.)
Open	J. C. Kline BSME — June	Interested in res. & dev. in thermodynamics or related fields. 1 summer's experience with earth moving industry.

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
		UNIVERSITY OF BRITISH COLUMBIA
Open	Inderjit Riar BASc — May	(Aerodynamics option.) Desire work in maintenance dept. preferably leading to position as design engr.
Open	Peter South BASc — June	Age 32, married; 15 yrs. auto mechanic. Summer experience with national aero. establishment. Interested in res. & dev.
		CALIFORNIA STATE POLYTECHNIC COLLEGE
Open	W. R. Scherer BSME — June	Interested in dev. or machine design leading to project or design engr. and eventual mgmt. responsibility.
Southern Calif.	P. G. Ruhle ME — June	Want job in general mech. design. Most interested in heat power (design and applications.)
Sacramento, Calif.	Henry Hanser BSME — June	Age 25, married, veteran. Desire work in air-conditioning or heat transfer field. Have 2 summers engrg. experience.
Open	J. P. Edgar BSME — June	Age 28, married. Armed service completed. Journeyman Machinist (4 yrs. apprenticeship, 1 yr. experience.) Interested in trouble shooting and dev. of machinery and processes.
Northern Calif.	S. J. Chan BSME — Sept. '60	Desire work in mech. design, training program leading to project engr. Have 2 summers work experience as mech. draftsman.
Open	H. S. Burden, Jr. BSME — June	Age 28, single. Interested in res. & dev. or machine design. 1 summer's experience as engrg. aide for Aerojet-General Corp., Liquid Rocket Plant, Sacramento, Calif. Graduate Radio Communications School, Scott AFB, Illinois. Radio Technician USAF, 1954–7.
Open	John Shanks BSME — June '60	Prefer opportunity in heat transfer or heating & ventilating lines. 1 summer experience in heating & ventilating as Mech. Engr. (Trainee). Norton AFB, San Bernardino, Calif.

Free service to employers and members

Continued on next page

1961 Engineering Graduates . . .

. . . who want to work in the industries served by SAE—continued.

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
Open	J. S. Arnold BSME — June	Desire position in design or sales with opportunity for advancement.
		CITY COLLEGE OF NEW YORK
East	Irvin Koniak BME — Feb.	Interested in res. & dev. or machine design.
Open	G. H. Owen, Jr. BME — Feb.	Desire position in gas turbine field pertaining to jet propulsion or power generating systems.
New York	Anthony Magistro BME — Jan.	Seeking job which might be first step in equipping me for responsible work as a design engr.
Open	L. H. Lustbader BME — Jan.	Interested in res. & dev. along auto. lines — leading to eventual managerial responsibility. 3 summer jobs have provided some practical experience.
New York	F. J. Kujan BME — June	Prefer job in any field of engrg. Especially interested in auto. & related industries.
East or Mid-west	K. Kizlauskas BME — Feb.	Age 27, married, USAF veteran. Interested in auto. field, especially engines or suspensions, design & testing. Hobbies — same as above, others — sports.
Open	Gerald Grimaldi BME — June	Prefer opportunity in field of production engrg. or power engrg.
Open	R. L. Bocchicchio BME — June	Interested in field of thermodynamics & heat transfer preferably with aero. company.
New York area	Richard Abramowitz BME — Jan.	Seek work with company in fields of propulsion or electromechanical design. Have some experience in drafting.
		DETROIT INSTITUTE OF TECHNOLOGY
Open	Robert Dorsch BSME — June	Prefer opportunity in the field of res. & dev., leading to eventual mgmt. responsibility.
Open	Andrew Koutaudes ME — June	Would like to work with testing materials laboratories because I had experience in my country (Greece).
		ECOLE POLYTECHNIQUE
Open	F. E. Morissette BScA (P. Eng.) — May	Age 23. Worked 2 summers in engrg. sales doing same work as engr. in "Process Engrg." Would be very much interested in admin. engrg. which involves contacts, etc. Speak & write French & English.
Montreal	Pierre Gadbois BSME — April	Desire position leading to admin. engrg. Past experience in air-conditioning and powerplant in aircraft industry.
Open	Rosaire Desbiens BSME — Sept. '60	Interested in machinery or auto. design. Experience in earthmoving and paper mills machinery maintenance.
		FENN COLLEGE
Cleveland Area	A. J. Riccio BME — July '60	Interested in work pertaining to product engr. involving varied projects & eventually leading to mgmt. responsibility. Would like training program but it is not mandatory.
Ohio	J. A. Kerzman BME — Ind. Opt. — July	Desire position in industrial engrg. or machine design fields leading to eventual mgmt. responsibility. Co-op experience. Chairman SAE Student Branch.
		FRESNO STATE COLLEGE
U. S.	Robert Shawl BS — June	Desire any type of work that might be useful to a future automobile dealer (mech. or adm.).
		GENERAL MOTORS INSTITUTE
Southwest	G. N. Morrison BS — Aug.	Would like you to consider my work in auto. design and testing. Have had some computer experience.
		UNIVERSITY OF ILLINOIS
Open	Robert Wolfberg BSME — Feb.	Interested in gas turbine res. & dev. work.
Open	D. G. Slane BSME — June	Age 25, army veteran. Experience in drafting & product engrg. Interested in res. & dev. or project engrg.
Open	J. S. Rohaly BSME — June	Interested in training program leading to project engrg. with eventual advancement to managerial responsibility. Have had 5 summers experience with International Harvester Co., Advanced Implement Engrg., Chicago.
Open	S. Ramalingam ME — Feb.	Prefer opportunity in design or mfg. in medium-sized co. with opportunity for advancement. Have 3½ yrs. experience in auto. mfg.
Open	L. J. Bergandi BSME — June	Seek job in design of auto. or heavy equipment. Had summer jobs on design with State Highway Dept.
		INDIANA TECHNICAL COLLEGE
Midwest	E. C. Meissner BSME — March	Desire a position with diesel eng. mfg. firm & am most interested in res. & design relative to application of diesel power in diesel-electric powerplants. Have had 6 yrs. experience in the diesel field.
		LAWRENCE INSTITUTE OF TECHNOLOGY
U. S.	D. I. Van Blois BSEE — June	Desire job with company working in the electronics field. 4 summers of work have provided me with some practical experience.
Detroit	Nicholas Voytovich BSEE — June	Aggressive & ambitious 20 yr. old student desires employment in the electrical design field.
		LOS ANGELES STATE COLLEGE
So. Calif. or Florida	M. D. O'Neill BSME — July	Desire work in machine or auto. design. 3 yrs. experience in testing rocket engines. 2 yrs. experience maintaining sports car for road racing activities.

Free service to

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
U. S.	J. P. Oakes BSME — Feb.	Age 26, married, USA veteran. 5 yrs. experience in various mechanical drafting and design. Prefer opportunity in sales or application engrg.
		MADRAS INSTITUTE OF TECHNOLOGY
Open	V. Sadanandam BSc. D. — July	Seek job which might be first step in equipping me for responsible work as quality control engr.
		MANHATTAN COLLEGE
Open	Jack Gelione BME — June	Interested in work in design or controls leading to eventual mgmt. responsibility.
		MARQUETTE
Milwaukee to Green Bay Area	Herb Roedel BSME — June	Desire ME experience along auto. lines leading to eventual mgmt. responsibility.
		UNIVERSITY OF MIAMI
Open	Sheldon Oletzky BSME — Dec.	Desire experience in engrg. aspect of company product with eventual position in sales & administration. Presently navigator with 6 mos. experience in missile field.
		UNIVERSITY OF MICHIGAN
Open	Thomas Fowler BS — Jan.	Seek job with company connected with powerplants (auto., diesel, turbine). Have 1 yr. practical experience in 6 cylinder engine plant.
		MICHIGAN STATE UNIVERSITY
Open	J. M. Pascasio BSEE — Sept.	Desire to work with company mfg. electrical accessories for automobiles. Interested in this work pertaining to product testing or engrg.
		MILWAUKEE SCHOOL OF ENGINEERING
Open	Daniel Wiencek BSME — April	Desire work in res. & dev. or machine design.
		MISSOURI SCHOOL OF MINES AND METALLURGY
Open	C. M. White, Jr. BSME — Feb.	Desire opportunity which will eventually lead to mgmt. responsibility.
Open	D. A. Ostmann BSME — June	Seek job which might be first step in equipping me for responsible work in production or as quality control engr.
South America	R. J. Leonard ME — Feb.	Desire training program leading to power engrg. & eventual managerial responsibility. Speak Spanish perfectly.
Open	G. E. Gaylord BSME — June	Age 22, single, military obligation fulfilled. Interested in gas turbine engines — dev. & design.
		NORTHROP INSTITUTE OF TECHNOLOGY
Southern Calif.	J. M. Cullen, III BSAE — Dec. '60	Desire training program leading to electronic guidance systems. Majoring in electronics under aero. degree program.
Open	F. H. Tomiyoshi BSAME — Dec. '60	Interested in position with aircraft mfr., airlines or aircraft repair service, preferably work connected with aircraft systems or powerplants.

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
East	Jim Stone BS-Aero — Nov. '60	Experience in many fields & desire to learn should make any job a challenge. Presently "man Friday" for Tylan Corp. Doing space vehicle component testing & analysis.
Open	J. N. Shovald BS-A/C Main. Engrg. — Dec. '60	Desire field service rep. type work in either aircraft or missile field. Single, age 28 & possess A & P License.
Southern Calif.	R. R. Myers BSAE — July '60	Desire eventual work in admin. engrg. Work with others preferred to isolated designing. Some experience in production equip. design.
Open	L. I. Hagino AETE — Oct. '60	Desire work leading to position as design engr.
Los Angeles	P. A. Hadnagy, Jr. BSAME — March	Age 25, married, USAF Vet. Extensive military experience in jet A/C. Desire position where I could learn & gain experience in field of aircraft maintenance and/or aircraft systems. Lacking only 3 mos. before eligible for FAA airframe & powerplant license. Prefer evening work.
Open	J. A. Fuller BSAME — Jan.	Desire position in field service, flight test or lab. test of missile and/or aircraft propulsion systems. Eventual goal is admin. position in this field. 4 yrs. USAF maint. on large A/C.
Western U. S.	J. A. Freedman BSAE — Jan.	Prefer position in res. & dev. branch of aero. corp.
Open	D. A. Fisher BSAME — June '60	Prefer liaison work or field service engrg. in the mechanical field.
Open	R. E. Hussey BS-AME — Sept. '60	Seek position which will lead to a responsible job in Res. & Dev. or Tech. Representation.
		OHIO STATE UNIVERSITY
Foreign	J. S. McKarns BSME, MSME — Sept.	Principally interested in thermoelectric power, nuclear energy applications, petroleum production & product engrg.
		PENNSYLVANIA MILITARY COLLEGE
U. S. Alaska	D. M. Davis BSME — June	Age 27, married, 1 child, USA veteran. Experience varied engrg. & chemical in coatings, textile & cellophane (all res. & dev.). Prefer opportunity in design, cost analysis or sales.
		PENNSYLVANIA STATE UNIVERSITY
U. S.	J. N. Fleck BS-Metal. — June	Prefer either production or res. & dev. work as a physical metallurgist. Have 2 summers work experience.
		UNIVERSITY OF PITTSBURGH
Calif. Arizona "The South"	K. A. Fulton BSME — Dec. '60	Prefer training program leading to sales engrg.
Open	Larry Schneider BS — April	Desire position in production with opportunities to learn the business & advance.
Open	J. R. Dougherty BSME — April	Interested in employment involving maintenance or dev. Technical experience with auto., air-conditioning & electrical equipment.

employers and members

Continued on next page

1961 Engineering Graduates . . .

. . . who want to work in the industries served by SAE—continued.

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
		PURDUE UNIVERSITY
Open	D. A. Glass BSME — June	4 summers experience in wide variety of engrg. positions. Desire design & dev. in auto. or related field.
Open	R. D. Haug BSME — June	Desire position in product design leading to eventual mgmt. responsibility. 85 wks. experience in product engrg. with a major auto. mfr. as a Co-op.
		QUEEN'S UNIVERSITY
Peru	J. F. Adams BSc — April	Age 23, single. Mechanically minded & interested in working with engines. Am as well enthused with design engrg.
		ST. LOUIS UNIVERSITY
East Coast	M. M. McCormick BS-Aero — Dec. '60	Have worked for Sikorsky Helicopters for 2 yrs., 10 mos. prior to entering college. Was experimental flight test crew chief for 2 yrs. Hold aircraft & eng. mechanics license. Took part in flight test at factory, Patuxent River, Md. & other test centers.
		SAN DIEGO STATE COLLEGE
San Gabriel Valley	Bill Lawver BSME — June	Desire work in machine design. 2 yrs. mech. drafting experience.
		UNIVERSITY OF SASKATCHEWAN
Canada	Edward Radwanski BE-Mech. — June	Age 24, married. Prefer opportunity in medium-sized co. doing design work or sales.
Western Canada	D. T. Peters BE-Mech — June	Engrg. experience limited to surveying for public works projects; however, personal desire & tests show preference for admin. engrg. in construction field; would also favor heavy equipment sales.
Open	R. N. Jacobs BE-Mech — June	Age at time of availability 22 yrs. Desire work as maintenance engr. with opportunity for advancement. 2 summers experience.
Open	C. H. N. Hodgson BE-Mech — June	Desire work in mech.-electrical design. Prefer medium-sized co. with opportunities for advancement to eventual managerial position.
		SOUTHWESTERN LOUISIANA INSTITUTE
Open	Martin Blaylock BSME — June	Desire training program leading to engrg. tech. service & eventual mgmt. responsibility. Have summer experience in engrg. tech. service.
		SYRACUSE UNIVERSITY
Open	D. J. Pettigrass BSME — June	Desire work directly connected with auto. res., dev., or production.
		TEXAS A & M
Open	R. L. Kennedy BSME — Feb.	Prefer opportunity in medium-sized co. doing sales work or design of internal combustion engines.
Open	W. J. Latimer BSME — June	Desire position in field of internal combustion engines leading to eventual mgmt. responsibility.

Preferred Location	Name, Degree, and Date Available	School and Field of Interest
		UNIVERSITY OF TOLEDO
Open	C. R. Jones BSME — June	Desire work in testing & dev. along auto. lines with opportunity for advancement. Have 1 yr. experience with air-conditioning & drying co.
		UNIVERSITY OF TORONTO
Open	Harold Jackman BASc — May	Prefer opportunity in eng. design or dev. Have both tractor & automobile experience.
Open	Harvey Siegel MASc — May	Mech. Engr. — Bachelor's Degree (1959) with honors. Res. for Master's Degree in heat transfer using electrical analog network in conjunction with CFR eng. experiments. Desires position in res. & dev. on any sort of prime mover with company which encourages initiative.
		TRI-STATE COLLEGE
New England	I. R. Philbrick BSME — Sept. '60	Receiving BSME in Sept. '60 with minor in drawing and design. Interested in field or sales engrg. Experienced as draftsman, auto. mechanic & construction equipment operator.
Northeast	J. E. Mixer, Jr. BSME — Oct. '60	Seeking a position in design or dev. engrg. Upper ½ of class; Military service completed.
		UTAH STATE UNIVERSITY
South America	L. T. Dahl, Jr. BS (Auto. Tech.) — June	Desire work as tech. rep. or field man for auto., truck, farm or heavy equipment firm. Lifetime preparation, training & experience. Fluent Spanish, lived 3 yrs. in Argentina. Presently finishing 3 yrs. Army helicopter maintenance. 27, married.
		UNIVERSITY OF WASHINGTON
Open	C. N. Larson MS in ME — Aug. '60	Age 23, married. Interested in engrg. mechanics or structures. Am presently working ½ time as a res. asst. at the University.
Seattle, Washington	J. L. Gruber BSME — March	Seeking employment with co. in design or mfg. 3 summers with a design group have provided some experience.
		WAYNE STATE UNIVERSITY
Open	K. H. Token BSME — Jan.	Prefer opportunity in machine design field with opportunities for advancement.
Open	Eli Berniker BSIE — Sept.	Interested in IE & ME applications in agricultural engrg. Have Dairy Hero mgmt. experience & 2 yrs. part time admin. IE experience in auto parts mfg. firm.
		UNIVERSITY OF WISCONSIN
Open	David Saltzman BS — July '60	Seek job which might be first step in equipping me for responsible work as design engr.

Free service to employers and members

Briefs of SAE PAPERS

Continued from page 6

cated in manner similar to that used for non-coated product.

New Approach to Vinyl Films on Steel. W. G. CRYDERMAN. Paper No. 180C. In Kaybar process, developed by Kaybar, Inc., Birmingham, Mich., vinyl film is spray-applied after fabrication and pattern is obtained by embossing steel; sequence of development of finished product and outline of steps required; advantages; same treatment may be given to aluminum of materials by modification of primer systems used.

Fusion Bond Coatings — New Technique for Plastic Cladding Metal, W. R. PASCOE. Paper No. 180D. Fluidized bed coating process "Whirlclad" for applying plastic coatings to variety of substrates is based on coating by dipping preheated object into bed of finely divided, dry fluidized powders which melt and fuse on heated surface to form continuous uniform film; advantages of process, applicable to steel, stainless steel, cast iron, aluminum and zinc alloy die castings, copper, bronze, brass, and glass; basic types of plastic fusion bond finishes available are cellulosic, vinyl, epoxy, nylon, polyethylene, and chlorinated polyether.

NUCLEAR ENERGY

Design Considerations for Radiochemical Laboratory in industry. L. C. SCHWENDIMAN. Paper No. 181B. Design requirements with regard to necessary space for work area, isotope storage, instrument and change rooms, offices, solvent storage, and lunch room; ventilation and air conditioning requirements; use of various hood designs, gloved boxes and other safety features; fire protection; provisions for radioactive waste disposal; recommendations made.

MISCELLANEOUS

Fuel Cells — Introduction, L. O. McGRAW. Paper No. 179A. Principle of fuel cells as specialized batteries, definition of some terms and fuel cell kinetics; substitution of intermediate redox systems for catalytic electrode to establish reactivity of fuel results in one form of so-called regenerative fuel cell; regenerative converters which employ thermal and electrolytic energy sources abide by same inherent Carnot Cycle limitations which restrict theoretical efficiences of conventional methods of power production; fuel costs.

Continued from p. 113

How to Improve Your Plant Layout

Based on paper by

N. L. SCHMEICHEL
Sterling National Industries

HERE are the steps which might well be taken to improve plant layout:

The first step is to make a product load analysis. This means to select a typical representative model or type from each product classification, generally the one having the largest sales volume. It might, for example, be fenders, grilles, hoods, trunk, and body doors.

The second step is to break down each representative model into its subassemblies and component parts. Up-to-date bills of material can be used to supply the information and from these the annual requirements can be determined.

Making out a route sheet is the third step. It will show such things as annual requirements, usual lot size or release, number of setups. And for operational routing — department, operation number, operation, work center, setup times, cycle times, and pieces per load from which is obtained the loads per year. The movement of material in loads and distance is shown and this is important in showing miles traveled in a plant per year.

The fourth step is posting, from the work route sheet by machine centers, the usual machine load data for determining the requirements planned and the capacities available. A specified normal or planned production capacity (such as a two-shift, five-day week) must be established as a primary objective.

Developing cross charts is step five. These are used to solve the complicated flow patterns and actual machine or work center relationships, and the revised layout is developed from them. This is the quickest way to get total distances moved for the existing layout. Equipment is then arranged to keep handling requirements at a minimum. The total of all new distances times cost per mile will predict material handling under the new arrangement, and interpolation will give the savings on an annual basis. If the savings in material handling will not recover the cash outlay for modifying the layout, you had better forget the project unless you are having to make a forced move.

If direct material handling cost savings are insufficient to amortize moving costs within a selected period of time, three indices must be used — indirect material handling, gravity utilization, and floor area loading density. These indices for before and after layout changes times occupancy rates (obtained from your accountant) will review potential savings and these may be compared to the square foot cost of new construction. Other indices to use to arrive at savings are those of aisle space, storage facilities, and storage volume utilization.

Scrutiny of manufacture

Evaluations should be made of work-in-process inventories, cycle times, automating, and other influences such as quality control. Careful analysis must be taken in attempting to apply historically sound expense control ratios. Highly automated plants will tend to show relatively higher expensive-to-productive labor costs. Only an overall expense study can give a realistic evaluation.

After preliminaries are completed there comes the developing of a three-dimensional model of all facilities and space involved. The expense of such a model is justified because it prevents errors not apparent in a two-dimensional layout or conventional drawings.

Finally, comes a comparison between last year's financial statement and an estimated statement for the new plan on the same sales level or the predicted sales level based on better deliveries and reduced backlog. Repeat this cycle

Continued on p. 114

Continued from p. 113

for the following years over which the project is to be amortized. Keep an eye on deductions from gross profit for their probable effect on the proposals. The main accounts affected are provision for depreciation and moving expenses.

These, then, are the figures management needs to pass judgment on the economic soundness of the capital or expense expenditure for new or revised facilities.

To Order Paper No. 189A . . . from which material for this article was drawn, see p. 6.

How to Calculate Effective Heat of Ablation

Based on paper by

E. R. G. ECKERT

University of Minnesota

ABLATION COOLING—used to protect missiles during re-entry through the atmosphere—is being evaluated for different materials. This is accomplished by calculation when material properties and flight conditions are known, and experimentation when they aren't.

This work is facilitated by an equation which presents the instantaneous heat balance in a very useful form. Physical parameters are separated as much as possible in this equation:

$$\dot{q}_{co} - \dot{q}_{rad} = m_s \left\{ \beta \left[i_{sg} + c\,(T_s - T_o) \right] + K \left(\frac{M_a}{M_c} \right)^p (i_{ro} - i_{so}) \right\}$$

where:

q_{co} = Convective heat flux from gas stream to solid surface per unit area and unit time

q_{rad} = Radiative heat flux per unit time and area

m_s = Mass loss per unit area and time

β = Ablation parameter

i_{sg} = Latent heat of conversion from solid to gaseous state

c = Specific heat

T_s = Temperature with which vapor leaves vehicle

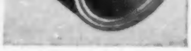
T_o = Temperature on nonablating surface

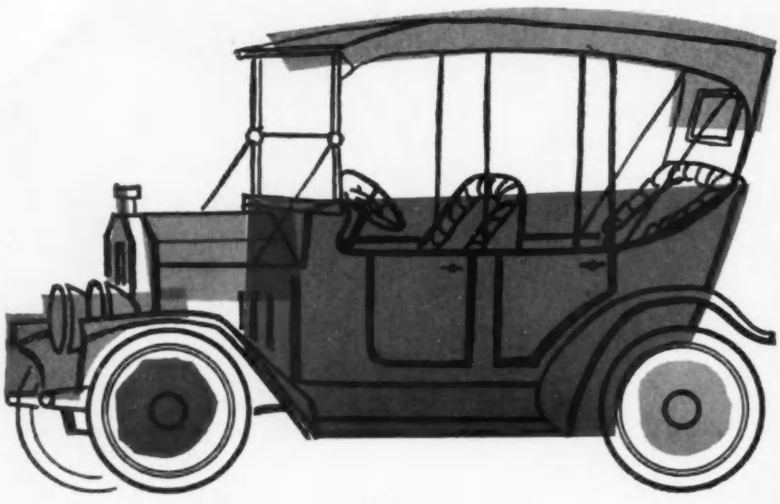
K = Constant which has the value 0.756 for laminar flow over a surface with constant pressure, 0.535 for two-dimensional laminar stagnation flow and 0.34 for turbulent boundary layer flow

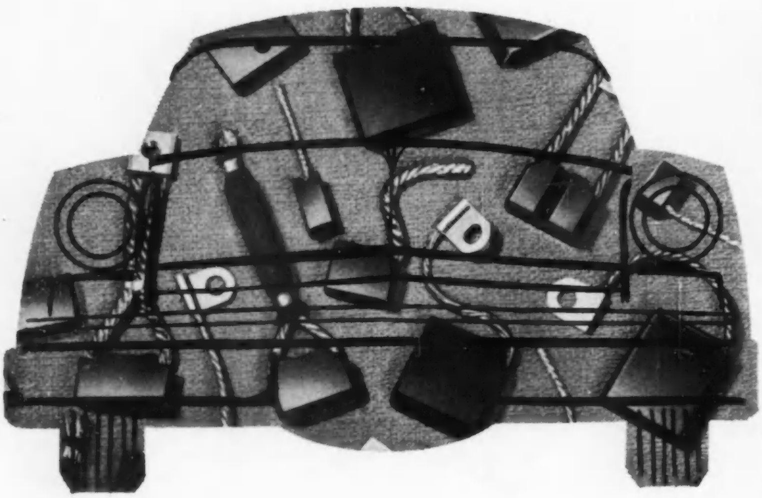
p = Exponent equal to 1/3 for laminar and 0.6 for turbulent flow

Continued on p. 118

Continued from p. 114







Continued from p. 114

M_a = Molecular weight of air

M_c = Molecular weight of coolant gas released at surface

i_{r_0} = Recovery enthalpy—the enthalpy which the air would assume at the surface when it was solid and uncooled

i_{s_0} = Enthalpy which air would assume on solid surface at the actual temperature resulting from the ablation cooling process

The left-hand side of the equation depends on the flow conditions (re-entry conditions) and on the shape of the vehicle. The surface material and the cooling process influence it only through the surface emissivity and through the surface temperature.

The right-hand side of the equation contains the parameters which are determined by the cooling process and by the ablating material. The term within the wavy brackets is therefore referred to as effective heat of ablation. It must be kept in mind that the effective heat of ablation is not a material property, but depends also on the external flow conditions especially through the third term. It is, however, very useful because it indicates how the various factors contribute to the effectiveness of the total ablation process. Values of the effective heat of ablation can be calculated when the material properties involved and the flight conditions are known.

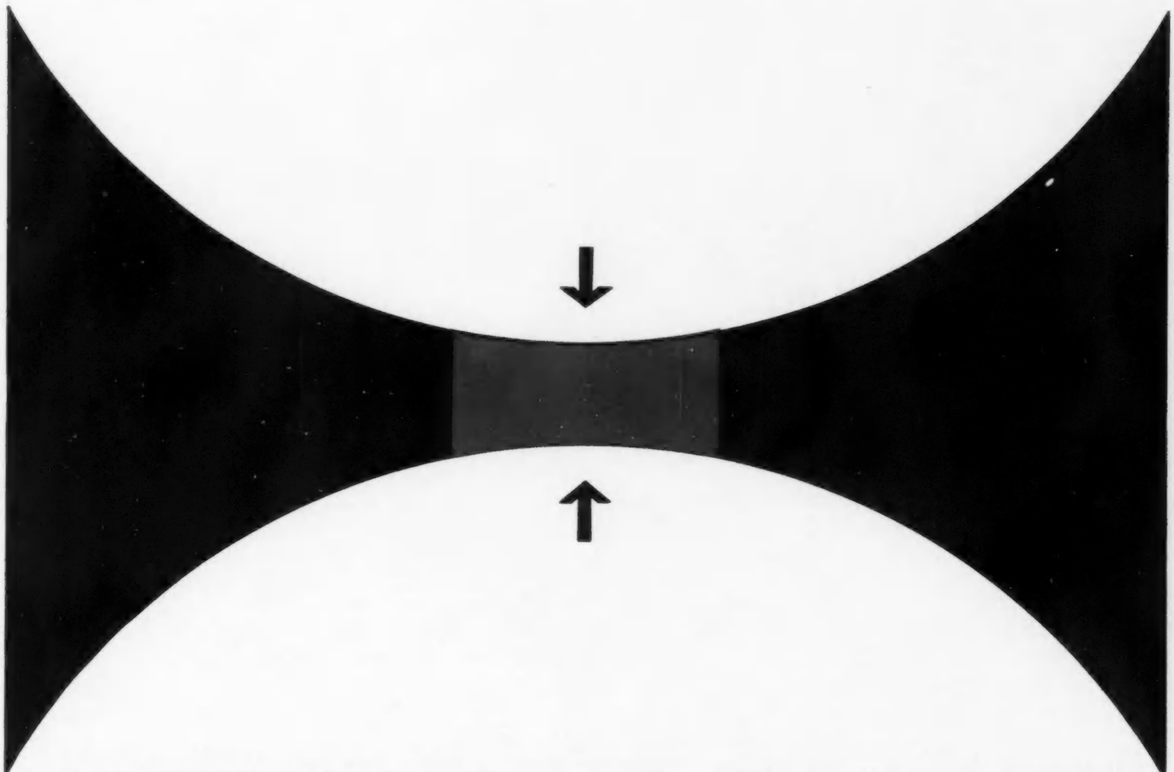
For many materials which are considered today—especially for composite materials—this is not the case and the effective heat of ablation has to be obtained from experiments. A serious difficulty arises in this connection in the effort to assimilate in the experiments the re-entry conditions and restrictive limitations are usually accepted in this connection.

The two experimental tools which contributed most to the development of ablation cooling are the exhaust from a rocket engine or a plasma jet which is heated by electric arc discharge. The second possibility results in higher values of the total enthalpy in the gas stream.

Models manufactured from the material to be investigated are exposed to the gas jet and the mass loss m_s per unit area and time is measured. The convective heat flux q_{c_0} from the gas stream to the solid surface and the heat flux q_{rad} by radiation have to be determined by separate experiments. Thus the equation allows the calculation of the effective heat of ablation.

Table 1 presents (see page 124) effective heats of ablation of reinforced plastics as measured in a rocket exhaust. Note the high values for phenolic or silicone reinforced with refrasil. The enthalpy change given in the equation has been found to be about 1000 Btu/lb. This value is only about 50% of the effective heat of ablation

Continued on p. 124



4 new miniature DELCO POWER TRANSISTORS

NOW, FROM DELCO RADIO, A COMPLETE LINE OF SMALL, HIGH-POWER TRANSISTORS!

	2N1172	2N1611	2N1612	2N1609	2N1610
V_{CB}	40	60	60	80	80
V_{EBO}	20	20	20	40	40
V_{CEO}	30	40	40	60	60
I_C	1.5 A	1.5 A	1.5 A	1.5 A	1.5 A
I_{CO}	200 μ a	100 μ a	100 μ a	100 μ a	100 μ a
H_{FE}	30/90	30/75	50/125	30/75	50/125
$V/_{Sat}$	1.0 V	1.0 V	0.6 V	1.0 V	0.6 V

The four new Delco transistors, plus the 2N1172 40-volt model, offer highly reliable operation in a new range of applications where space and weight are restricting factors.

Designed primarily for driver applications, Delco's versatile new transistors are also excellent for amplifiers, voltage regulators, Servo amplifiers, miniature power supplies, ultra-low frequency communications, citizens' radio equipment and other uses where substantial power output in a small package (TO 37) is required.

Special Features of Delco's Four New Transistors: Two gain ranges. Can be used on systems up to 24 volts. Can be mounted with the leads up or down with the same low thermal resistance of 10° C/W. Dissipation up to 2 watts at a mounting base temperature of 75°C.

Available in volume production. Write for full engineering data.

DELCO RADIO
DEPENDABILITY RELIABILITY

Newark, New Jersey
1180 Raymond Boulevard
Tel.: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel.: Exbrook 3-1465

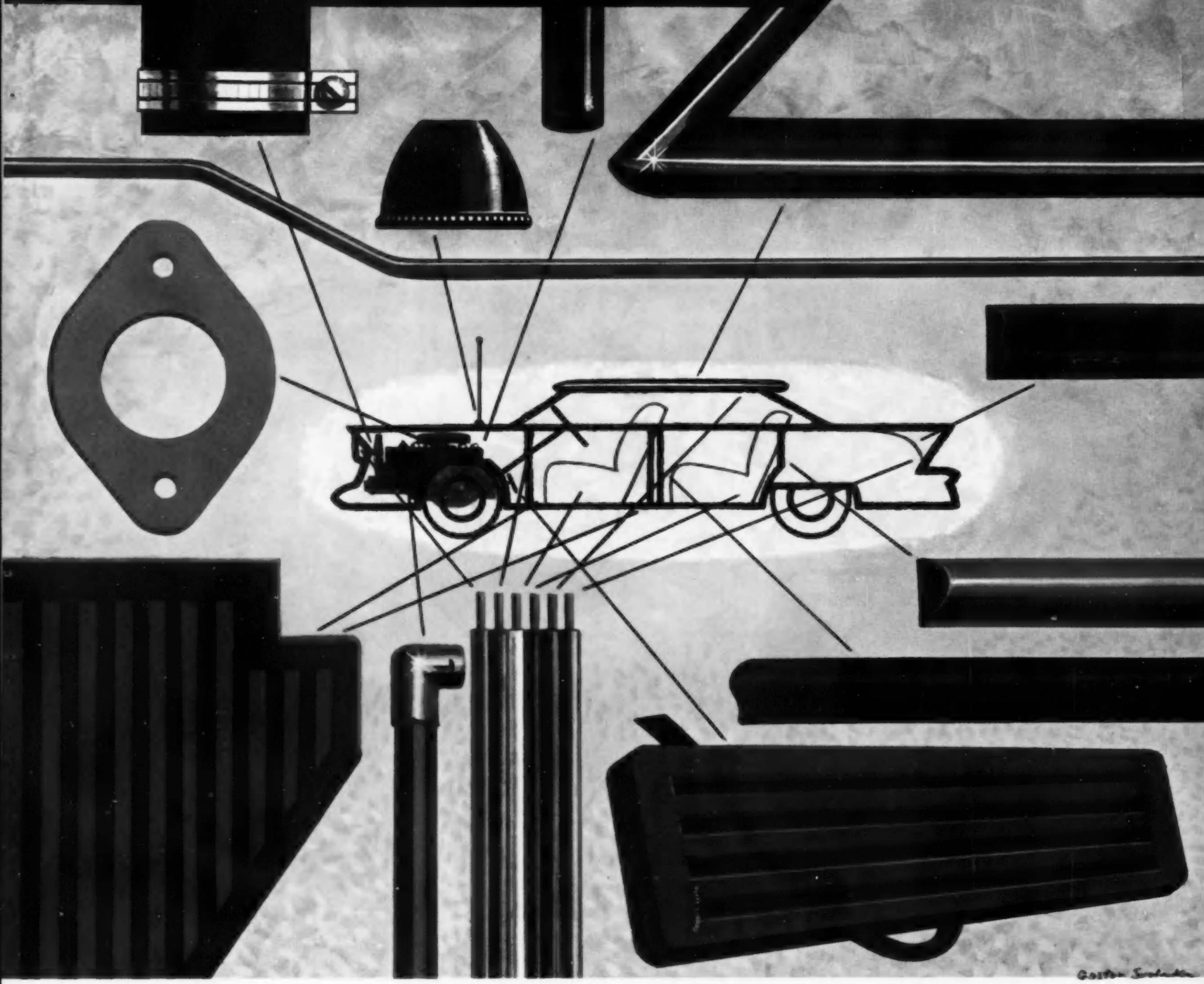
Chicago, Illinois
5750 West 51st Street
Tel.: Portsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
Tel.: Trinity 3-6560

Division of General Motors • Kokomo, Indiana

Naugatuck PARACRIL OZO

THE OIL-RESISTANT, OZONE-RESISTANT NITRILE RUBBER



Great new advance in automotive rubber

Here is a new rubber that's unmatched for oil, weather, and abrasion resistance. It's new PARACRIL® OZO, the finest achievement yet in the nitrile rubber field. PARACRIL OZO's properties are tailor made for many modern automotive parts—for everything from weather stripping to oil seals and hose. PARACRIL OZO gives you a whole series of important advantages, including:

- significantly superior ozone resistance
- excellent fuel and oil resistance
- several times greater abrasion resistance
- permanent retention of bright colors for exterior styling and easily traceable wiring and other interior parts

Look into PARACRIL OZO. Discover for yourself its new design possibilities...its unlimited color...its high quality. Contact your nearest Naugatuck representative at the address below.

Naugatuck Chemical

Division of United States Rubber Company Dept. A Elm Street Naugatuck, Connecticut

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE: Rubexport, N.Y.

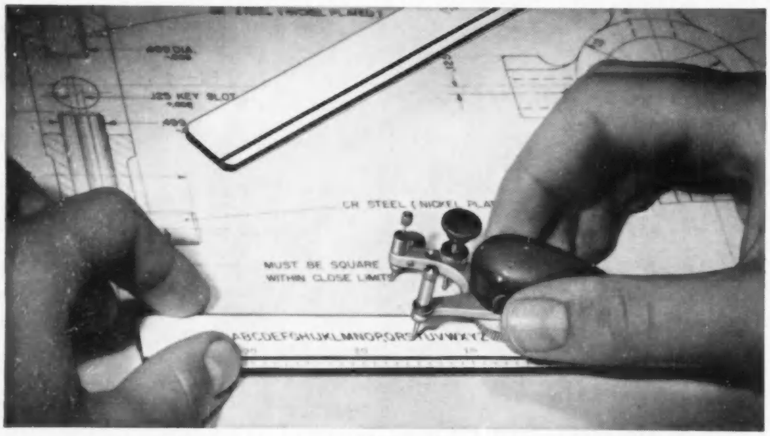
Some Ideas

for your file of practical information on drafting and reproduction . . . from **KEUFFEL & ESSER CO.**

When it comes to lettering – plain or fancy – professionals the world over turn to LEROY® Equipment by K&E. In drafting rooms, art departments – not to mention schools, business offices, churches, clubs, hospitals – LEROY has become almost as necessary as pencil and paper.

Truly, there's no magic about LEROY – just a beautifully simple idea, translated into products which reflect the highest manufacturing skill and imagination. Not easy, we grant you . . . but not magic.

However, to keep the LEROY line constantly up to the changing requirements of the times – that *does* require a wizard. Fortunately, we have just such a gentleman firmly settled on the K&E payroll. And he begs that we report several of the more recent minor miracles of LEROY right here and now. So, in the famed standard, sans-serif lettering template, let's make with a little . . .



abracadabra

Templates

Every year sees new additions made to the already long list of LEROY templates. Case in point: the new electronic tube symbol templates for use in one of the most modern, fastest changing industries of them all. Also, there are foreign language templates (such as Russian and Greek), music templates, special designs, and a variety of handsome type faces (Caslon, Cartographic, Bernhardt Modern to name some newer additions).

The best advice we can give for keeping current on LEROY templates is to have the LEROY catalog on hand. (It just so happens that we recently put out a brand new edition of the catalog, and it's yours for the asking. See coupon at right.) Finally, of course, we should add that if you don't see what you need in our catalog, don't despair. We'll produce it, *custom-made*, to your design – as we have done for thousands of others.

A "Built-In" Pencil Point

The business of stopping work to put a sharp point on a lettering pencil is now largely over and done with, thanks to another new LEROY item. The point of the new LEROY "020" pencil never blunts or dulls – it's permanently sharp. And that, we submit, is a pretty sharp idea. The lead of this new pencil is an unvarying .020 inches in diameter, from one end to the other. All that's necessary to repoint is to advance the lead with a turn of the pencil

shaft. No need to remove it from the scriber, by the way. This new pencil fits all LEROY scribers, and guarantees faster, smoother work. As to appearance – all lines drawn with the "020" are perfectly uniform, and of exactly the same density (a careful balance, chosen to give good wear without sacrificing print-making quality). You never saw pencil work look so good.

The Pen With A "Built-In" Inkwell

Here's your ticket to faster ink work with far fewer refills – K&E's new LEROY Reservoir Pen. You'll be amazed at the mileage you can get between refills with this newly perfected pen. Its refillable cartridge holds enough ink for many hours of smooth, uninterrupted lettering, thus eliminating the need for daily cleaning. The pen's cartridge is airtight – made of a non-porous, unbreakable, translucent material. The level of ink is always visible, and any non-solvent, waterproof India drawing ink can be used (for best results and quicker, easier filling we recommend the LEROY Lettering Ink-Cartridge #2950).

A tiny weighted needle inside the pen's feed tube assures a clear passage of ink from reservoir to point. Light vertical shaking of the pen activates this needle, removing any particles which may have settled in the tube when the pen was set aside. The needle also provides efficient cleansing action when you wash out the pen.

LEROY Reservoir Pens are furnished in seven sizes, from 00 to 5, for use with all LEROY scribers. Ideal for lettering work, the points glide easily over paper, cloth or film based surfaces, producing sharp, uniform lines that reproduce crisply.

Order Your LEROY Catalog Now

Other new additions and improvements – too numerous to go into here – are described in the new LEROY catalog. The coupon below brings your copy, free.

KEUFFEL & ESSER CO., Dept. SJ-9, Hoboken, N. J.

Please send me the latest catalog on LEROY Lettering Equipment by K&E.

Name & Title ____________________

Company & Address ____________________

____________________ 2838

More Performance At Less Cost:

HYDRA-DRIVES®

CDB POWER SHIFT TRANSMISSION

A torque converter...and 4-speed transmission in one compact package!

Proved in hundreds of vehicles for four years, these units assure top work output of heavy-duty equipment . . . at a lower initial cost than other models of comparable performance. Engine lugging and heavy shock loads are eliminated. A 3 to 1 torque multiplication makes starting fast and effortless—even with heaviest loads.

Just a flip of the operator's lever accomplishes power shifts within each range and without any interruption of the power flow.

With four speeds forward and reverse, the CDB Hydra-Drives Power Shift Transmission is ideally suited for vehicles which must travel in both directions during a normal work cycle. Rated at 550 ft. lbs. input torque, it can be used with a wide range of internal combustion engines up to 250 H.P.

The CDB model illustrated above is used in connection with a size "C" drop box.

A BDB model is also available, for use with a size "B" drop box on equipment up to 175 H.P.

Another Product of... **ROCKWELL-STANDARD CORPORATION**

ROCKWELL STANDARD

Transmission and Axle Division, Detroit 32, Michigan

Continued from p. 118

for phenolic-glass or silicone-glass and only about 20% for the refrasil reinforced plastic. The rest is essentially due to the blocking effect of the released gas.

■ To Order Paper No. 185A . . . on which this article is based, see p. 6.

Table 1 — Effective Heats of Ablation of Reinforced Plastics

Resin	Reinforcement	Btu/lb
Melamine	Glass cloth	2200
Phenolic (91LD)	Asbestos	2500
Phenolic (91LD)	P-100 refrasil (SiO_2)	6400
Silicone (DC-2106)	Fiberglass	1900
Silicone (DC-2106)	Asbestos	1100
Silicone (DC-2106)	P-100 refrasil (SiO_2)	6300

(Free stream enthalpy 3320 Btu/lb)

CRC Deems Vapor Lock Test Valid

THE CRC vapor-lock test technique, which measures the effect of certain variables on hot fuel handling characteristics of passenger cars, has been deemed "useable and valid." And according to CRC Report 343, "1958 CRC Vapor Lock Tests," it shortens fuel test time considerably.

The technique was evolved from over 300 tests conducted at Ford's Arizona Proving Ground and Ethyl's San Bernardino Laboratories during four weeks in the fall of 1958 by 30 men from 25 companies on six test cars representing modern types.

Studies were made of:

- Repeatability of test results on different days and by different test crews.
- Effects of variable soak and idle times.
- Part-throttle versus full-throttle acceleration performance.
- Use of extra test instrumentation to permit recording of fuel pressure, float level, and vehicle speed.
- Test fuel containers instead of car fuel tanks.
- Effect of fuel volatility on vapor losses indicated by fuel economy runs made under various ambient temperature conditions.
- Suitability of chassis dynamometer facilities for measuring the hot fuel handling characteristics of cars.

Results of these tests and a description of the test sequence are given in CRC Report 343. Another survey using this technique will be made in the fall of 1960 and will be the subject of a later CRC report.

To Order CRC Report No. 343 . . . from which material for this article was drawn, see p. 6.

CRC Finds Need for Standard Seal/Lube Tests

STANDARD test techniques for predicting the compatibility of seals and lubricants are needed by a majority of the seal, lubricant, and petroleum companies according to a survey made by the Coordinating Research Council. Other industry reactions to the survey relate to:

- Types of seals and lubricants in use.
- Conditions under which seals and lubricants are expected to perform in service.
- Current test methods for evaluating the relationship of seals and lubricants.
- Field status of seal and lubricant compatibility.

Continued on p. 129

Super-strong trailer built 2,850 pounds

This 32-ton trailer is a progressive example of how to get maximum strength with least weight and low cost. The main frame members are a wide-flange beam design built up by welding USS "T-1" Steel plates together. "T-1" Steel, with a minimum yield strength of 100,000 psi, has enabled the Engineering Department of Martin Trailer Division of the Hyster Company to design to approximately two times their normal static stress and still maintain adequate factors of safety.

Eight-foot cross members are formed channel sections of USS MAN-TEN High Strength Steel, which has a minimum yield point of 45,000 psi in thicknesses of ¾" and under. The combination of these two USS steels produced a weight saving of 2,850 pounds and represents a 21% decrease in dead weight of the unit.

Welding procedure. The "T-1" Constructional Alloy Steel beams are welded by submerged arc. The MAN-TEN Steel cross members are tack-welded to the main beams of "T-1" Steel, then finish welded by the shielded arc method.

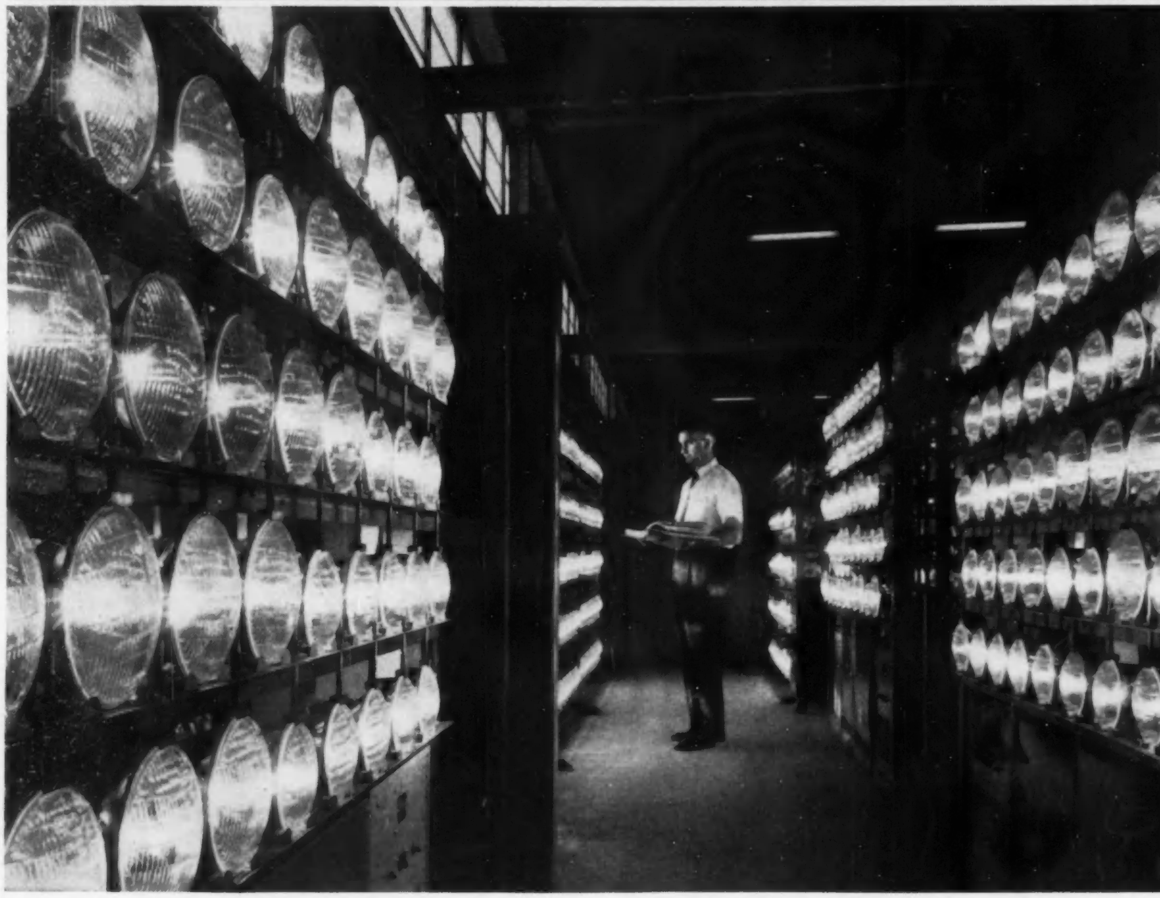
"T-1" and MAN-TEN Steels pay off. The trailers are built by the Martin Trailer Division of the

Steel This mark tells you a product is made of modern, dependable Steel.

Continued from p. 124

• Correlation of field results and

A lifetime of light crammed into 15 days



Tung-Sol headlamps are subjected to the severest set of tests in the industry — from raw materials to finished product — before they reach the highways of the world.

One of the most critical final examinations they face is the life test. First, samples of each production run are checked for maximum candle-power, amperage and wattage at design volts. They are then placed in the aging racks and burned at accelerated voltages to assure full completion of their designed life. In this case the low beams of 12 volt headlamps burn continuously at accelerated voltages for fifteen days to make sure they'll produce the 500 hours of peak performance required by S.A.E. specifications.

This test is an example of Tung-Sol's leadership in quality mass production of headlamps . . . leadership which started at the turn of the century when Tung-Sol produced the first successful electric headlamp. Automotive Products Division, Tung-Sol Electric Inc., Newark 4, New Jersey. TWX:NK193.

TUNG-SOL® HEADLAMPS · MINIATURE LAMPS · FLASHERS

Which pre-paint phosphate coating is best for you?

Continued from p. 129

49-page report are:

Continued from p. 124

- Correlation of field results and present test methods.
- Extent of cooperation by industry members which can be expected in conducting test programs.

Resulting recommendations which appear in CRC Report 345, "Field Survey of Automotive Lubricants and Seals," are as follows:

(1) A task group be set up to deliver a specific design for a machine or machines to be used in the development of test techniques for concurrent testing of seals and lubricants.

(2) Reference seals and lubricants for each major automotive component be selected as soon as feasible.

(3) First efforts in the development of test techniques and field correlation be started with automatic transmission and rear axles, followed by engines and power steering.

This report contains 37 pp. including three appendices.

To Order CRC Report No. 345 . . . from which material for this article was drawn, see p. 6.

New Test Evaluates Axle Tube Corrosion

A NEW and reliable technique for evaluating moisture corrosion properties of gear lubricants has been devised by a Coordinating Research Council group. Designated CRC L-33-959, it duplicates conditions of normal service where moisture condenses on metal parts in the gear case under cyclic ambient temperatures.

The test is applicable to both fresh oil samples and used oil drawn from previously operated gear cases. It was developed for extreme-pressure lubricants, although it is also adaptable to a less chemically active mineral base of synthetic lubricants.

As described in CRC Report 342, "Development of Research Technique for Determining Moisture Corrosion in Rear Axle Gear Lubricants," L-33-959 calls for the standard 4-hr motoring period, followed by a 162-hr storage period. During the latter, the test unit resides in a controlled temperature storage box for 18 hr the first day, and for 24 hr the succeeding six days. (A one-day test is also described.)

Both tests utilize a Spicer axle supplied with uncoated gears. The axle assembly is driven for 4 hr by an electric motor at 2,500 rpm with an oil sump temperature at 180 F. Subsequent to that, the assembly is stored in a temperature controlled box at 125 F for either one or seven days.

Conclusions of the Moisture Corrosion Test Panel which appear in the

Continued on p. 130

Continued from p. 129

49-page report are:

(1) Moisture corrosion does occur in the rear axles of stored vehicles lubricated with some oils having acceptable extreme-pressure properties.

(2) Such corrosion would probably have contributed to early failure had the units been put into normal service.

(3) The new moisture corrosion test technique differentiates between oils which vary in their ability to prevent moisture corrosion.

(4) Laboratories which used the new technique and the same reference oils were able to reproduce test results.

(5) The complete axle test is a reproducible and repeatable tool for evaluating moisture corrosion. Bench tests or simplified procedures could possibly range oils in the same order of rust protection ability, but would require further study.

To Order CRC Report No. 342 . . . from which material for this article was drawn, see p. 6.

8 New CRC Reports Issued Since January

THE following Coordinating Research Council reports have been released for distribution and are available from SAE Headquarters. (This is a complete list of CRC reports released since publication of the listing on page 95 of the January, 1960, SAE Journal.)

Aviation Fuels

CRC 346 — "Electrostatic Discharges in Aircraft Fuel Systems — Phase I"

Lubricants

CRC 342 — "Development of Research Technique for Determining Moisture Corrosion in Rear Axle Gear Lubricants" (Contains Research Technique for Determining Moisture Corrosion in Rear Axle Gear Lubricants — CRC Designation L-33-959).

CRC 345 — "Field Survey of Automotive Lubricants and Seals".

Motor Fuels

CRC 343 — "1958 CRC Vapor Lock Tests".

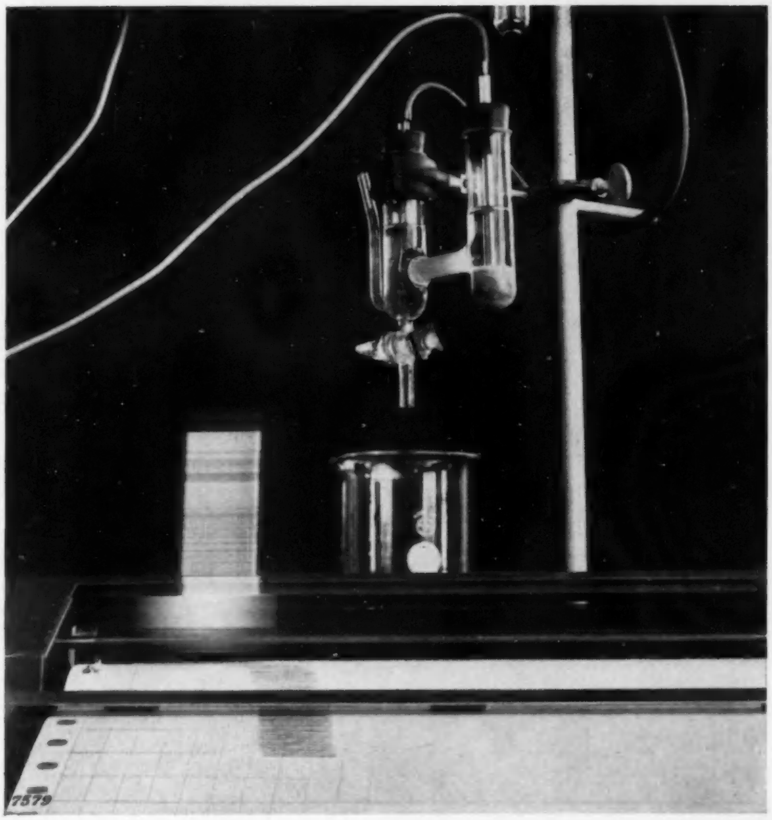
CRC 344 — "Analysis of the 1959 Road Rating Exchange Data".

CRC 347 — "Development of Techniques for Measuring Gas Temperatures in Internal Combustion Engines — Final Summary Report".

CRC 348 — "Octane Number Requirement Survey — 1959". Contains Research Technique for Determination of Octane Number Requirements of Passenger Cars Over the Operating Speed Range — CRC Designation E-15-559).

CRC 349 — "1957 CRC Vapor Lock Tests".

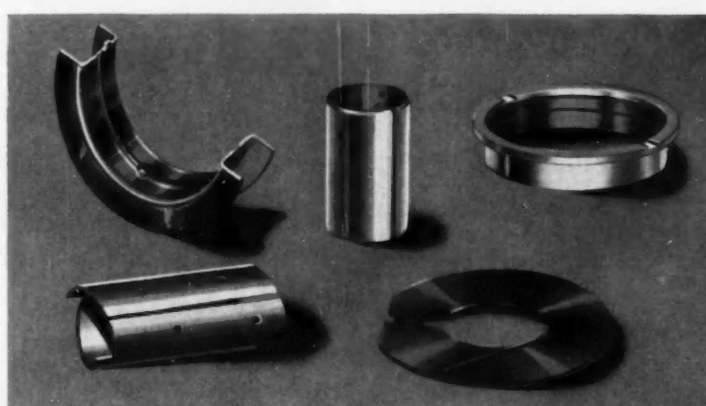
ANALYTIC "BLOODHOUND" SNIFFS OUT SECRETS OF BEARING CORROSION



WE USE THIS HYPERSENSITIVE DEVICE TO TRACK DOWN ENGINE BEARING CORROSION TO ITS SOURCE. This instrument needs only a minute fragment of metal for accurate analysis. Consequently, engine bearing corrosion can be traced from its beginning through complete destruction of the bearing surface. Because test variables are minimized, Federal-Mogul engineers can accurately relate degree of corrosion to specific engine operating conditions. This analytical tool is in continual use in our laboratory, assisting research on many different projects. Prevention of corrosion and development of new bearing alloys are high on the list!

SUCCESSFUL BEARING PERFORMANCE depends on selecting the proper alloy for the operating conditions to be met. Federal-Mogul engineers have had years of experience with bearings and applications of all kinds . . . and this wealth of knowledge is available to bearings users. This is one reason why F-M sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers are chosen for use in virtually everything from baby buggies to heavy industrial cranes.

FEDERAL Mogul



There's much valuable data in our Design Guides on sleeve bearings, thrust washers and bushings; and in our brochure on spacers. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11035 Shoemaker, Detroit 13, Michigan.

FEDERAL-MOGUL sleeve bearings bushings-spacers thrust washers DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

SPEEDOMETERS and interior lights employ the lighting characteristics of LUCITE for better viewing of dials . . . including the diffusion of light.

PARKING LIGHT of LUCITE acrylic resin gives sparkling visibility, resists heat, impact and is shatter-proof. It stands up to rugged conditions including flying pebbles, road dirt and oils.

TAILLIGHTS of LUCITE give maximum visibility because of their highly efficient light transmission. They resist cracking, crazing, sunlight, moisture . . . retain beauty for life of the car.

Easy moldability, extra strength and clarity—plus long life—make LUCITE® suitable for many uses

Many automotive engineers find the properties of Du Pont LUCITE acrylic resins help to solve new, creative design problems. Keep up to date on automotive engineering with LUCITE by sending for our informative new brochure "A New Look at the Product Design Qualifications of a Popular Plastic, LUCITE". Just fill in and mail the coupon below.

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U.S. PAT OFF

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

LUCITE® *acrylic resins*

one of Du Pont's versatile engineering materials

Zytel® nylon resins · **Alathon®** polyethylene resins · **Delrin®** acetal resins

E. I. du Pont de Nemours & Co. (Inc.), Dept. JJ-9
Room 2507L, Nemours Bldg., Wilmington 98, Del.

Please send me information on the following:

☐ LUCITE® ☐ ZYTEL® ☐ ALATHON® ☐ DELRIN®

Name__________

Company__________ Position__________

Street__________

City__________ Zone______ State______

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

Self-Guiding Bus Trains
New Concept for Mass Transportation

Based on paper by

NORMAN KENNEDY and WOLFGANG S. HOMBURGER

University of California

WHAT this country needs for urban rapid transit is a vehicle with the flexibility of a manually operated bus, the speed, comfort, and safety of a railcar, and the economy of automatic operation.

In recognition of this need, the Chicago Transit Authority is considering the possibility of self-guiding bus trains to travel at speeds of 60–70 mph on puncture-proof tires over exclusive lanes of grade-separated expressways. Construction would be lower than for conventional rapid transit structures, noise levels would be lower, and it would be relatively simple to install guidance systems on existing expressways. The buses would be single, manually operated vehicles in outlying areas, but they would be coupled to form trains for automatically controlled runs over exclusive rights-of-way into the congested areas.

Road and Rail Combination

A somewhat similar proposal calls for a fleet of automatic-conventional buses, much like existing diesel-powered vehicles. These would be manually controlled while picking up passengers on outlying routes. On reaching the central district, they would move into a freeway median and enter a track, switch from driver to automatic control, and run to and through the downtown area guided by electronic controls. Presumably, a bus would have both diesel and electric power.

Roadway Width

The roadway need be no wider than the distance between outside wheels; a two-way track would be about 24 ft wide and cost less than systems now proposed. Some sort of flange on the wheels would be required for use on the track. The use of individual vehicles at all times would obviate the delays incident to forming trains and make for flexibility. Drivers would be used only in the nontrack, outlying areas and so perhaps save labor costs. The automatic control would permit high-speed operation. As a city grows out from its center, the track part could be extended and the system would grow as needed, just as freeway systems do.

■ **To Order Paper No. 210C . . .**
from which material for this article was drawn, see p. 6.

CRC Issues Octane Ratings for 1959 Cars

THE Coordinating Research Council's 1959 octane number requirement survey is now available from SAE as CRC Report 348, "Octane Number Requirement Survey." Based on data submitted by 32 laboratories, the 119-page report contains octane number requirements of 575 cars manufactured in the U. S.

Third in Series

The 1959 survey was the third in a projected series of annual statistical survey of a current year's cars, and was made in conjunction with studies of new design and special interest models.

To Order CRC Report No. 348 . . .
from which material for this article was drawn, see p. 6.

The American Automotive Industry—the world's

Schrader global facilities supply

AIR CONTROL Since 1844

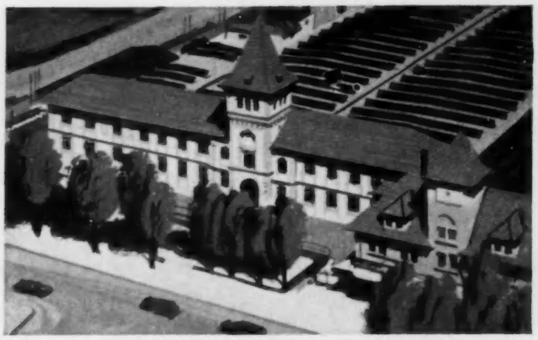
The famous Schrader valve operating principle—the Ace of Standardization—assures most practical performance and service in the world's far corners.

SILICONE NEWS from Dow Corning

greatest enterprise—depends on tire accomplishments

U.S.A. Tire Manufacturers abroad with reliable tire valves

AMERICAN QUALITY is international. When America builds vehicles abroad, each part must meet the same standards it would have to meet here.



FOR EXAMPLE THE EUROPEAN COMMON MARKET embraces 6 countries. Schrader's new Dubied plant in Pontarlier, France, serves this tremendous area.

EASY AVAILABILITY is a must in foreign production. Schrader facilities abroad provide valves and service tools to both manufacturers and service people.

SCHRADER'S SYSTEM of valve interchangeability is based on engineering simplicity. Language is no barrier to appreciation of quality.

No single American company or industry goes it alone abroad. To meet the standards of quality the world expects of us, it must rely on skills, knowledge and facilities of other American companies nearby. That is why our Automotive, Tire and Tire Valve Industries have circled the world. From France to Australia, for example, Schrader works with American Tire and Automotive companies to spread the countless benefits of American industrial effort. Schrader's job: The use of these facilities is further assurance that your vehicles produced anywhere in the world provide the best in performance wherever Schrader tire valves help protect tires.

Schrader®
a division of **SCOVILL**

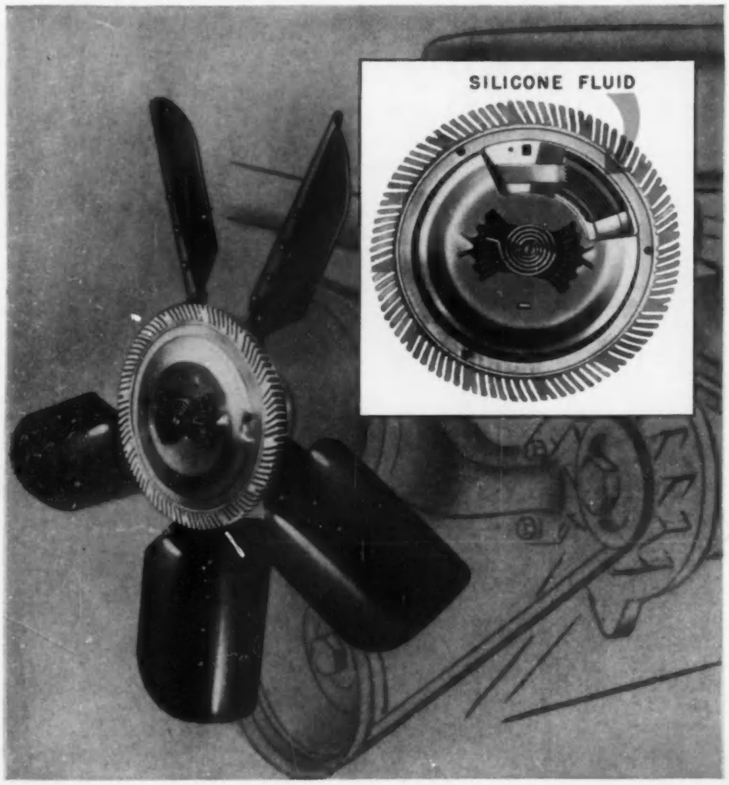
A. SCHRADER'S SON • BROOKLYN 38, N. Y.
Division of Scovill Manufacturing Company, Incorporated

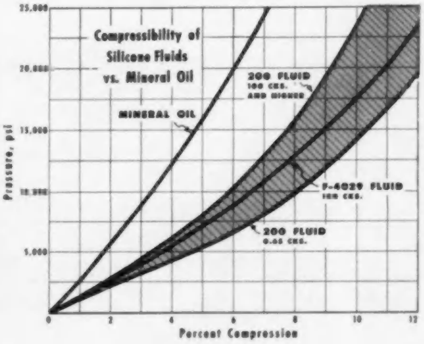
FIRST NAME IN TIRE VALVES

FOR ORIGINAL EQUIPMENT AND REPLACEMENT

SILICONE NEWS from Dow Corning

Versatility For Designers





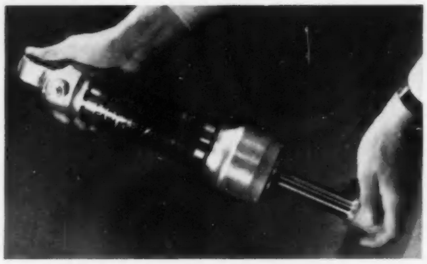
Compressibility Advantage. The exceptional versatility of Dow Corning silicone fluids makes possible many new designs—is also used to increase the efficiency of existing products. Compressibility at high pressure is an excellent example of a characteristic put to a practical advantage. Designers at Cleveland Pneumatic Tool Company developed "liquid springs" for the Lockheed F-104 Starfighter with 30% smaller oil chambers than shock absorbers that depend on organic fluids. Because the silicone fluid specified has much greater compressibility, it takes only 26 cubic inches of fluid to cushion each of the main landing wheels.

Silicones Improve Cooling Efficiency, Increase Horsepower, Reduce Noise

At high car speeds, engines waste valuable horsepower driving fans when cooling is least needed . . . yet fail to provide sufficient cooling at low speeds. Is there a solution to the problem? Yes, it's the temperature sensitive Visco-Drive developed by Eaton Manufacturing Company.

As underhood temperature rises, the automatically regulated Visco-Drive increases fan rpm to produce the required cooling; permits greater cooling efficiency at low engine speeds without the disadvantage of fan noise at high speeds.

Dow Corning 200 Fluid is specified as a viscous drive medium because it's many times more stable than petroleum-base oils. According to Eaton engineers, using a silicone fluid assures reliable, uniform performance over long periods of time under widely differing conditions. Such dependable performance is attributed to the fluid's unusual combination of properties — retention of near-constant viscosity over a wide temperature span; exceptional resistance to breakdown due to shear; and resistance to gumming and oxidation.



Uniform Damping. Miniaturization of instruments, from accelerometers to d/p cells, has been attained by effective use of silicone fluid as the damping medium. Improved performance is another benefit. Both are major advantages realized through the unique combination of properties available only from Dow Corning silicone fluids.

For your copy of the fact-filled, designers reference "Engineering Guide to Silicone Fluids", write Dept. 8009.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

[15] X-A-R [30]

TECHNICAL INFORMATION

CHEMICAL COMPOSITION

X-A-R steels are furnished at two specified carbon ranges. These are 14 to 20 carbon for X-A-R 15 and 25 to 30 carbon for X-A-R 30. The balance of the typical composition is:

Manganese	.80%	Chromium	.65
Phosphorous	.020	Molybdenum	.20
Sulphur	.028	Zirconium	.06
Silicon	.60		

TYPICAL MECHANICAL PROPERTIES

	At Brinell Hardnesses of: 363	400
Tensile Strength, psi	180,000	200,000
Yield Strength, psi	165,000	180,000
% Elongation in 2"*	17	16
% Reduction in Area*	56	55
Charpy V Impact at —75°F.	12 (Ft. Lbs.)	7

*Based on standard .505" specimen

ENGINEERING DATA

Resistance to Atmospheric Corrosion (Rural, Marine, and Industrial Environments)	3-5 times copper-bearing or carbon constructional steel
Compressive Yield Strength, psi	Approx. equal to Tensile Yield Strength
Ultimate Shearing Strength, psi	Approx. equal to Tensile Yield Strength
Modulus of Elasticity, psi	29/30,000,000
Endurance Limit (rotating beam)	60% of Tensile Strength
Coefficient of Expansion per °F.	70°F. to 200°F.—.0000062

FABRICATION

Cold Bend Test: Moderate bending can be performed within the usual range of hardnesses. For free bending, it is recommended that a mandrel be used not less than ten times the thickness of the metal through an angle of 90°.

Welding: Low hydrogen electrodes are recommended for welding X-A-R steels. The grade of electrode used is dependent on the strength requirement of the weldment.

Burning: X-A-R steels can be flame cut without pre-heating or stress relieving after cutting.

COMPLETE METALLURGICAL SERVICE

In addition to the information given in this folder, there is a great deal of detailed data available to steel users covering all characteristics of X-A-R steels. Furthermore, a thoroughly competent metallurgical service organization is available to work with you on any application problem you may have.

X-A-R STEELS ARE AVAILABLE AT THESE STEEL SERVICE CENTERS

BENEDICT-MILLER
Lyndhurst, New Jersey

JOSEPH DEMSEY COMPANY
Cleveland, Ohio

DUCOMMUN METALS & SUPPLY COMPANY
Los Angeles, California

INTERSTATE STEEL COMPANY
Evanston, Illinois

LOCKHART IRON & STEEL COMPANY
Pittsburgh, Pennsylvania

MARSH STEEL & ALUMINUM COMPANY
Kansas City, Missouri

O'NEAL STEEL, INCORPORATED
Birmingham, Alabama

SALT LAKE HARDWARE COMPANY
Salt Lake City, Utah

A. C. LESLIE & COMPANY, LIMITED
Montreal, Canada

15 X-A-R 30
ABRASION RESISTANT STEELS

New Members Qualified

These applicants qualified for admission to the Society between July 10, 1960 and August 10, 1960. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section: J. R. Carmell (A).

Buffalo Section: Robert E. Dutcher (M).

Central Illinois Section: Emidio L. Gaspari (A), Jerald Dwight Gentry (J), Richard J. Zych (J).

Chicago Section: Andrew Blaauw (M), Douglas William Dickinson (M), Walter Fisher (M), Wayne D. Hendrickson (J), Elbert A. Hoffman (M), Walter F. Klima (A), Charles M. McClure (A), James W. Mueller (M), Edward C. Oldfield (J), Gunther Pfeifer (M), Frank M. Poskozim (M), Edward P. Zelnis (M).

Cincinnati Section: Albert H. Dall (M), John G. Roberts (M), James Cody Williams (M).

Cleveland Section: Alan C. Birchler (J), Joseph V. Bosilievic (M), William D. Cameron (M), Charles H. Junge (M), Chester R. Mielke (J), William A. Parilo (A), Joseph Thomas Podnar (A), Donald W. Prideaux (A), Francis Sevcik (M), H. Lansing Vail, Jr. (M).

Colorado Group: Kurt F. Kircher (A).

Dayton Section: Roger L. Frantz (M).

Detroit Section: Paul B. Appeldoorn (A), Veli Hulusi Basat (M), W. B. Calhoun, Jr. (A), Clifford Anders Coffey (M), Nelson R. Droulard (M), James L. Eyre (A), Charles P. Fowler (M), Thomas A. Harris (M), John W. Hogan (A), R. B. Holmes (M), Emerald Howe (A), Shyr-ing Hu (J), Gerald L. Knight (J), Serge Kulmatycki (M), James Edward Luxenberger (A), Robert E. Manion (J), Ralph McClintock (J), Samuel D. McCready (M), Donald McKenzie (J), Carl P. Meder (A), Arthur William Moesta, Jr. (M), Thomas F. Moormann (M), N. Paul Morgan (M), Donald Thomas Mullaney (M), Albert W. Post (J), Samuel B. Robbins (M), Walter C. Root (M), Iain McMaster Scott (A), Keneth H. Taylor (A), Walker G. Thorsby (M), Christianus van der Zon (J), Harry C. Van Matre (M), James A. Winnale (J), George H. Wolenter (J).

Fort Wayne Section: Allan Vegell (J).

Hawaii Section: Curtis L. Baskin (A).

Continued on p. 144

New Members Qualified

Continued from p. 143

Indiana Section: Marvin H. Birlingmair (M), Harold Henderson Dice (M), Walter G. Fuetterer, Jr. (J), Frank R. Hubler (M), Robert L. Sharpe (J), Richard L. Sprague (M), Thomas A. Stewart (A).

Kansas City Section: Gerald G. Nixon (J).

Metropolitan Section: Lee Ballard (M), William W. B. Crickman (A), Edward D. Hook (J), Carl Orsini (J), Donald L. Pasquine (M), Robert E. Ruhfel (M), Clarence H. Sample (M), Robert William Thomson (M), James W. Turner (M), Charles O. Van Zant (A).

Mid-Continent Section: Miguel De-Assis Villaca (J).

Mid-Michigan Section: Louis H. Ravitch (M).

Milwaukee Section: Barrett N. Alexander (J), Arthur James Slingerland (M).

Montreal Section: Gordon Walter Little (M), Charles E. B. McConachie (M).

New England Section: Paul J. Barnico (M), Albert S. Kelley, Jr. (A), John L. Riddle (M), Julien R. Weigel, Sr. (A).

Northern California Section: Ralph Blodget (M).

Ontario Section: Brian Gregory Barden (J), Earl Kitchener Brownridge (M), Lewis Lees Buckley (A), Neville John Edgar Hartwell (M), Paul Ferdinand Hartz (A), William Robert Moggridge (M), Maurice Keith Wing (M).

Oregon Section: Alfred Calderaro (M), William A. Prothero (A).

Philadelphia Section: Benedict R. Buinewicz (M), James David Conboy (M), Oswald A. Holland (M), W. Haddon Judson (M), Donald J. Klopp (J), George W. Knoll (A), John H. Warren (J).

St. Louis Section: Edgar Ralph Schneider (A).

Salt Lake Group: Stephen James O'Brien (A).

Southern California Section: Michael Dzama (A), C. J. Howard (A), D. Frank Howeth (A), Andrew J. Kotzar (M), Morris Kramer (A), Vincent G. Magorien (M), Donald Carl Roudenbush (M), William James Scott (A), Cameron W. Seitz, Jr. (M), Henry Wilson Styers (A), Stanley Young (A).

Southern New England Section: Carl Leonard Broman (J), James A. Cronin (A), Girard S. Haviland (M), Francis Edward Lajoie (M), Edward P. Trider (J).

Spokane-Intermountain Section: Vernon T. Ward (A).

Syracuse Section: Maurice William Burgher (M).

Texas Section: Rip Nichols (A), Woodrow P. Silverman (M).

Twin City Section: James G. Welch (A).

Washington Section: Norman H. Petersen (M), N. E. Promisel (M), William Hardy Risteen (M).

Western Michigan Section: Hans-Rolf Hertzsch (M).

Outside Section Territory: Douglas Elton Brotherton (J), Charles W. Davis (M), David E. Knapp (J), Thomas J. Koon (M), Donald Murray (A), William Merriel Shook, Sr. (M), Kevin Timothy Shyne (J).

Foreign: Prabhat Tapan Basu (J), India; Donald Marcus Kelway Marendaz (M), So. Africa.

PLASTICS
in Design Engineering

New Teflon* FEP resin enables Garlock to supply mechanical and electrical parts of complexities never before achieved.

New developments in TEFLON FEP shapes and parts by Garlock. With the commercial availability of Teflon FEP, Garlock can now fabricate mechanical and electrical components never before possible with Teflon TFE. The reason is this—whereas TFE must be processed like powdered metals, the new FEP has the advantage of being melt-processed in conventional extrusion and injection molding equipment.

Think of what this means to you as a designer. You can now specify Teflon for the most delicate and complex shapes you may design. Teflon FEP opens whole new avenues of design possibilities . . . parts of the most intricate shapes . . . wall sections of minimum thinness of .020"-.030" . . . pieces with the closest of tolerances. Garlock also furnishes Teflon FEP in rod stock for ready cutting and machining.

Another important point. Developed as a supplement to Teflon TFE, the new FEP resin exhibits the same fine physical properties of chemical inertness, top thermal stability, excellent dielectric strength, and outstanding anti-stick and frictional characteristics. FEP is rated at a continuous service ceiling of +400°F, will resist extreme cold down to −395°F.

At low temperature, FEP has more impact resistance than any other known plastic. It is virtually unaffected by weather and remains unchanged when subjected to ultra-violet light and ozone attack. Finally, water absorption of FEP is zero!

Turn to Garlock—and their years of experience in fabrication of plastics—for more information on stock shapes and intricate parts of new Teflon FEP. The Garlock representative serving you will be glad to give you complete details. Call him at the nearest of Garlock's 26 sales offices throughout the U.S. and Canada. Or, write for catalog, Garlock Inc., Palmyra, New York.

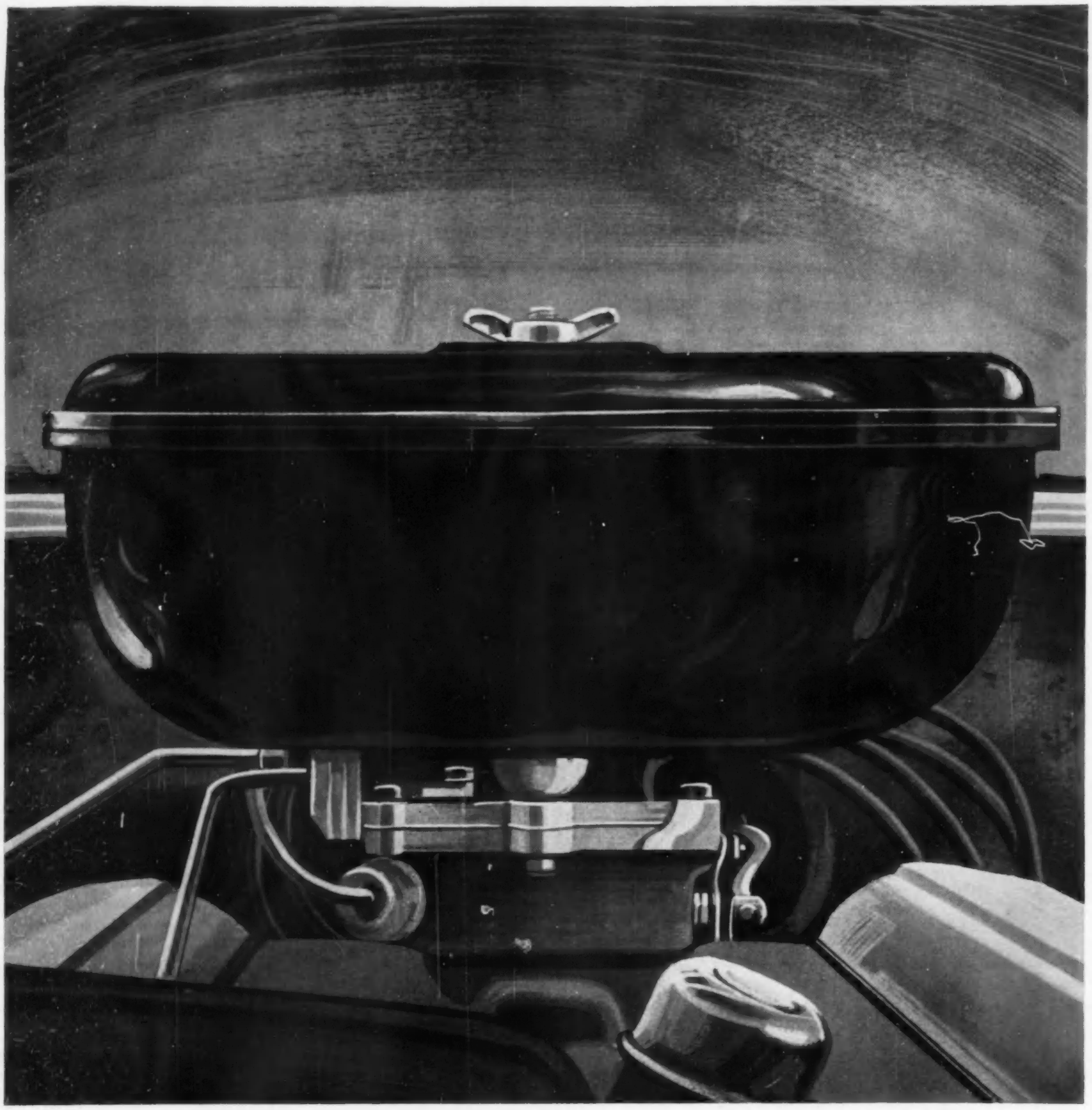
GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Du Pont Trademark for TFE and FEP resins



Applications Received

The applications for membership received between July 10, 1960 and August 10, 1960 are listed below.

Alberta Group: J. R. Caverhill

Baltimore Section: John W. Messer

British Columbia Section: Gerard Doeksen

Buffalo Section: Elton C. Schwinger, Jr.

Central Illinois Section: Gene R. Jones, Robert Le Roy McNabb, Frank G. Siler

Chicago Section: Harvey William Gordon, Karel Klima, James Louis Kurtz, James H. Lowe, David Edward Thorn

Cincinnati Section: Will Kenneth Brown, Jr., James Richard Santangelo

Cleveland Section: Robert A. Horvath, David L. Huntsberry, Norman C. Jackson

Colorado Group: R. Glenn Doolittle, Richard F. Frenzel

Detroit Section: Richard P. Averill, Howard A. Callendar, Harold E. Croswell, John F. Blamy, Robert Carl Dodt, William Samuel Freas, Donald Lee Jones, Donald Holt Loughridge, Wolfgang Otto Schunter, Terry A. Tetens, E. Stephen Tokarchuk, David J. Jay

Fort Wayne Section: Donald John Just, Raymond Charles Valentine

Indiana Section: John Riley Calvin, Dwight O. Crim, Joseph John Neff, Richard P. Edwards

Metropolitan Section: Ira Robert Ehrlich, Raymond Bernard Grontkowski, Edward Heinzelman, Jr., Andrew J. Herschel, Harold McDonald, George Henry Marks, Robert Lincoln Pike, Serge Valin, Kenneth Barrow Wood, Jr., Roger B. D. Wright

Mid-Michigan Section: Mark Lane Henfurth, Lawrence W. Moriarty

Milwaukee Section: John Alvin Cahoon, Ronald L. Luebke, Eugene Joseph Musbach

Montreal Section: John Stewart Farley, Gaétan Morin, Fumio Motomura, Gerald Albert Suek

New England Section: Edward Benson Cook

Northern California Section: William D. Evans, David Leslie Blomquist, Robert William Ingham, Dwight Emerson Robertson, Ronald Earl Sorenson, Irving P. Siminoff

Northwest Section: Vernon H. Salisbury

Continued on p. 148

Applications Received

Continued from p. 147

Ontario Section: Sydney Leon Britton, Robert Edward Dart, George William Jamieson, Cecil E. Middick, William Malcolm, William Warren Nesbitt, Gerald J. Ray, Jack Simpson, John Robert Williams, Andrew H. Yamanaka

Oregon Section: Earle S. Preston

Philadelphia Section: F. W. Chapman, Jr., Richard Carl Duehne, Harry William Lenczyk, Jr., Francis P. Lentine, Samuel R. Mami, Charles Carroll McClelland, Carl Jacob Schreiner, Gerald George Kroninger, Richard Joseph Teti

Pittsburgh Section: Edsel Ernest Bishop, Eugene A. March

Rockford-Beloit Section: Clarence E. Henson

St. Louis Section: Jerome Adelbert Galiley

Salt Lake Group: Larry J. North

San Diego Section: Richard Hudson Burkett, Laurence Richard Fusselman, Charles Maynard Richards Jr.

South Texas Group: S. Ray Bell

Southern California Section: Clifton J. Chandler, Ralph G. Cook, Edwin N. Friesen, Captain John L. Halloran, William Fred Pieper, Robert John Ploe, Stanley B. Van Dalsem, Laurence Wisberger Jr., Kiyoshi Ernest Yamane

Southern New England Section: Furman Hovey Martin, III, Joseph Serrin Nelson

Syracuse Section: Terrance Michael Hebert

Texas Section: Wendyl Bruce Baker

Twin City Section: Robert Victor Albertson, Kenneth H. Rice

Virginia Section: Neil W. Zundel

Western Michigan Section: George A. Bolles, Norman Edward Overway, Larrence Van Elzelingen

Outside Section Territory: Richard Jay Clarke, Loy M. Clemmer, Richard Loran Day, Richard John Fer, Bert James Minshall, Homer Eugene Nye, John Roger Wilson

Foreign: Harjest Sigh Dhindsa, India; V. G. Rajagiopalan, India; Charles Allan James Ramsay, Australia; Bindu Madhava Bandlatmakur Rao, India; Juan Carlos Ryan, Argentina; Horace Robert Swatman, England; Ravindar P. Vohra, India

first in fire fighting for over 50 years!

Waukesha has been building engines for fire equipment for over fifty years. Since one of its first internal combustion engines for fire fighting service was sold to the Chicago Fire Department in 1908, Waukesha has built into these fire engines quick acceleration, flexibility, immediate response to varying load demand, and the reserve of extra power needed for emergency overload.

Waukesha Fire Fighter Engines are in use throughout the United States, and in many foreign countries, in the finest fire equipment built by leading manufacturers.

WAUKESHA FIRE FIGHTER ENGINES ...up to 300 hp

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS. • New York • Tulsa • Los Angeles
Factories: Waukesha, Wis., and Clinton, Iowa

477

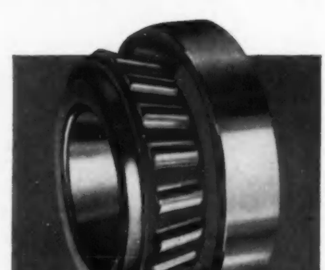
Checking on performance of Waukesha Fire Fighter Engines.

STAMINA . . . heavy loads go farther on Bower Bearings

Moving a missile from coast to coast takes bearing muscle aplenty. And its on-schedule arrival depends on perfect —repeat, *perfect*—bearing performance.

To roll the load surely, safely, on time you can depend on Bower bearings. The extra assurance, extra service they give results from definite design advantages. Spherically generated roll heads, higher flanges and larger two-zone contacts translate into trouble-free service, reduced maintenance, longer bearing life.

Whether you build, buy or maintain trucking equipment—or *any* product that uses roller bearings—ask for Bower first. You can select from a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.



BOWER ROLLER BEARINGS

Bower Roller Bearing Division • Federal-Mogul-Bower Bearings, Inc. • Detroit 14, Michigan

Growing Preference at Nation-Wide Fleets Proves

Take SUSPENSE out of SUSPENSION with LEAF SPRINGS

You can depend on leaf springs!

In addition to prime function, their design characteristics—

- Cushion thrusts of "starts" and "stops"
- Maintain alignment of springs, frame, and axles
- Control load balance
- Minimize sidesway
- Absorb shocks

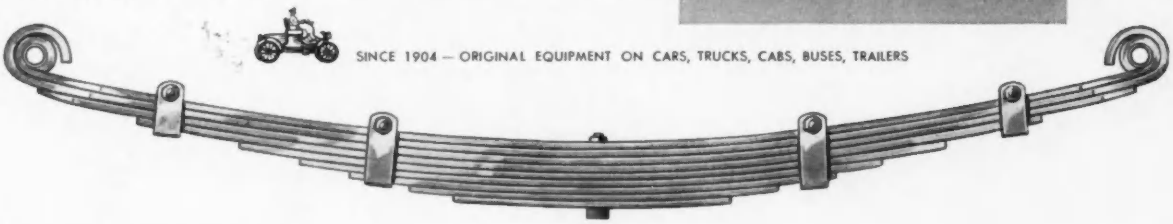
Simplicity, strength, dependability, and long wear *are inherent in correctly engineered leaf springs.*

DSP *Leaf* SPRINGS

DETROIT STEEL PRODUCTS DIVISION

of *Fenestra* INCORPORATED

6000 Caniff Avenue, Detroit 12, Michigan



SINCE 1904 — ORIGINAL EQUIPMENT ON CARS, TRUCKS, CABS, BUSES, TRAILERS

What material is best for truck bodies ?

Growing Preference at Nation-Wide Fleets Proves

THE TREND IS TO LIPE

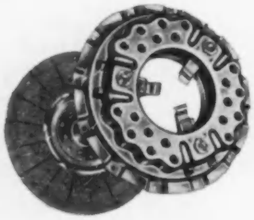
Miller Motor Express of Charlotte, N. C. has installed Lipe Clutches in 40 units. More are in process.

Month by month, year by year, the increasing number and size of orders for Lipe Heavy-Duty DPB Clutches bears out the growing preference of fleet men.

This preference is soundly based on the fleet men's own experience. They try DPB's. They keep performance and maintenance records. They compare. And the results are plain to see:

More ton-miles per year . . . more engagements between shop-stops . . . lower cost of maintenance when maintenance *is* necessary. By any yardstick of costs, these are figures difficult to dispute.

And they all add up to another indisputable fact: *The trend is to* LIPE.



There is a Lipe clutch to meet requirements of vehicles 18,000 lbs. GVW and up; for torque capacities from 200 to 3000 ft. lbs. For application assistance and specific data, contact the company direct.

LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

What material is best for truck bodies ?

USS COR-TEN High Strength Steel !

COR-TEN Steel provides: *50% higher yield point, 4 to 6 times greater resistance to atmospheric corrosion, weight savings up to 40%, increased payloads, lower maintenance and operating costs.*

One of the most important decisions you can make in selecting your next delivery truck body is the material from which it is made. No one material has all the characteristics needed to produce the perfect delivery truck body but from the experience of thousands of users and numerous body builders, USS COR-TEN High Strength Low-Alloy Steel most nearly fills the needs.

USS COR-TEN High Strength Steel adds strength and payload capacity to these General Baking Company truck bodies built by Boyertown Auto Body Works.

For experience from users, let's go to the General Baking Company, New York. This organization has thousands of trucks delivering bread in more than half the states in the Union. Bread trucks must never fail to make deliveries or they lose business. Efficient operation is important, so they must use trucks that assure low operating and maintenance costs and have the largest carrying capacity. Bodies must resist highway corrosion, shock, twists and strains. In this service, General Baking uses a high percentage of truck bodies made of USS COR-TEN High Strength Steel.

For experience from a body builder, we'll take you to Boyertown Auto Body Works, Boyertown, Pennsylvania. This company has built up a highly successful business featuring truck bodies made of high strength steel.

They use USS COR-TEN Steel for the entire body—framework, floors, side panels and doors. The greater strength of COR-TEN Steel saves approximately 650 pounds of weight in the average sized delivery body. They found that COR-TEN Steel's greater fatigue resistance resulted in much lower maintenance, that paint lasts more than twice as long. What's more, COR-TEN Steel's ability to take battering and to resist abrasion and denting goes over big with customers.

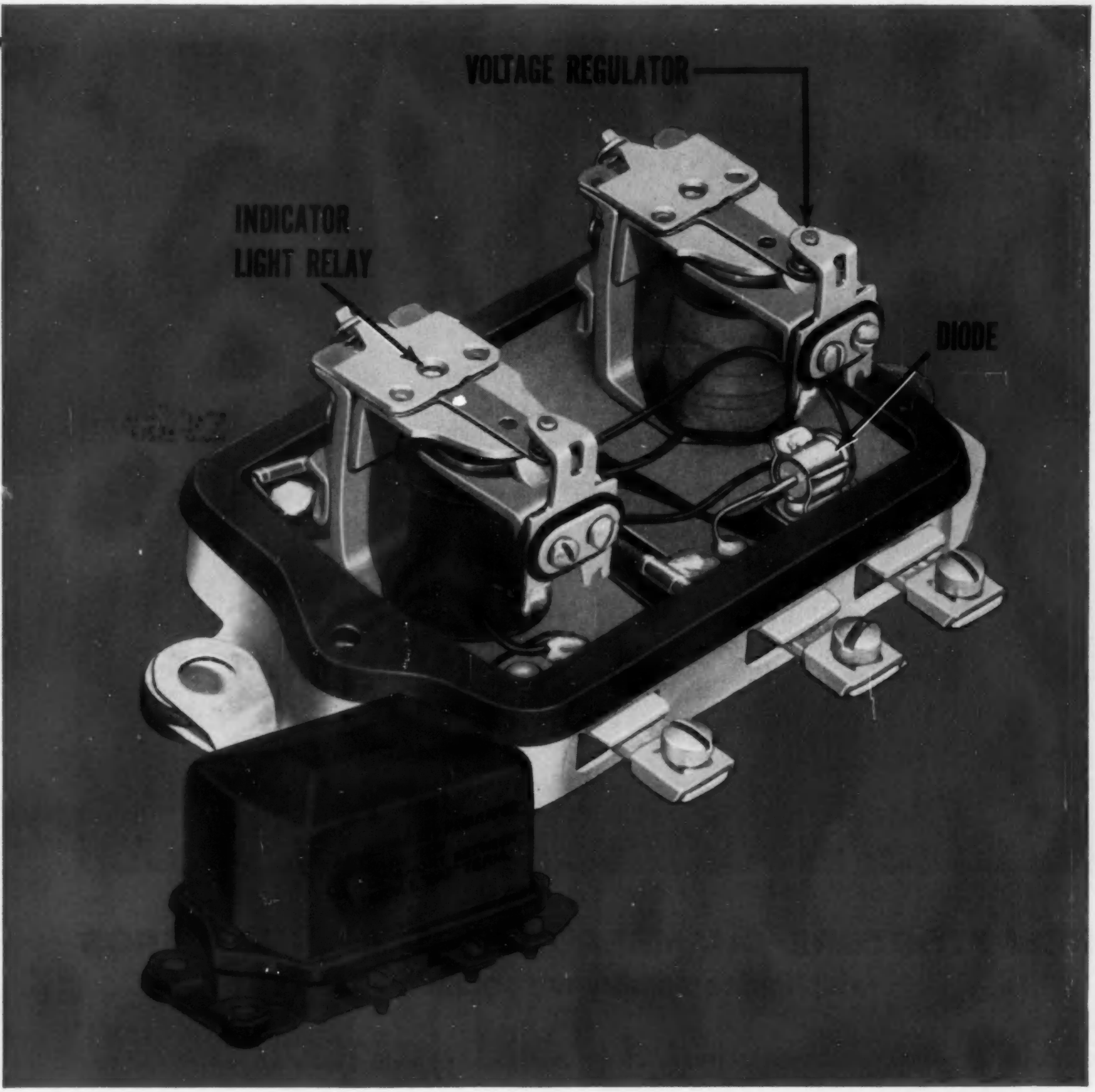
For more information on USS High Strength Steels, COR-TEN, MAN-TEN and TRI-TEN brands, or *extra* strength "T-1" Constructional Alloy Steel, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, MAN-TEN, TRI-TEN and "T-1" are registered trademarks

This mark tells you a product is made of modern, dependable Steel.

United States Steel Corporation – Pittsburgh
American Steel & Wire—Cleveland
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
United States Steel Export Company

United States Steel



AND TRANSISTORIZED VOLTAGE REGULATORS

permits high field current for improved generator performance with low non-inductive current through the contacts for greatly extended contact life. Models are available for circuits containing either ammeters or indicator lights. All units are temperature compensated to better match battery voltage requirements.

Both the full-transistor and the transistorized models have the same mounting dimensions as standard regulators.

Whichever model you choose for your new vehicles or for replacement on present ones, you can be sure of reduced servicing and extended battery life. Available from your car or truck dealer or through the United Motors System.

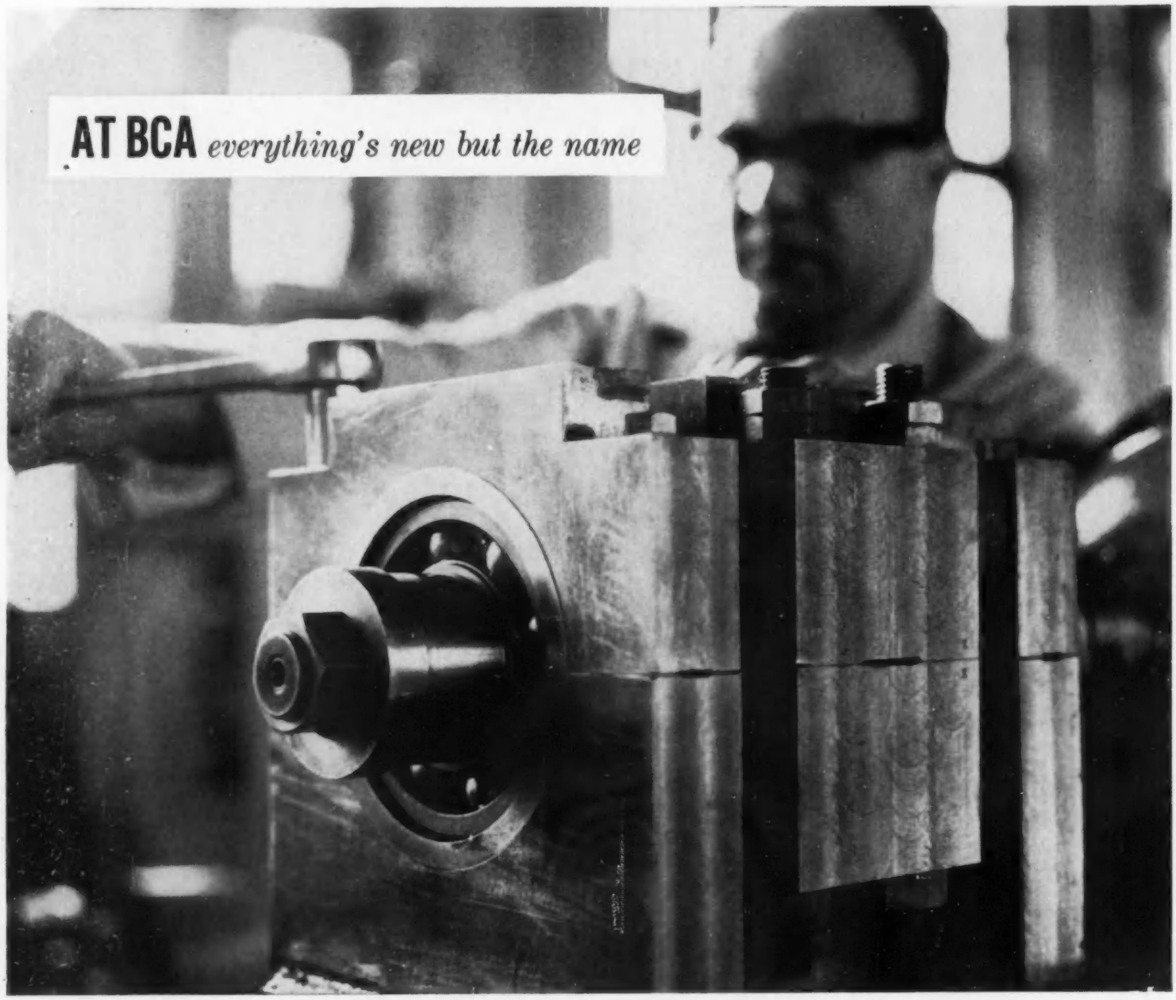
FROM THE HIGHWAY TO THE STARS

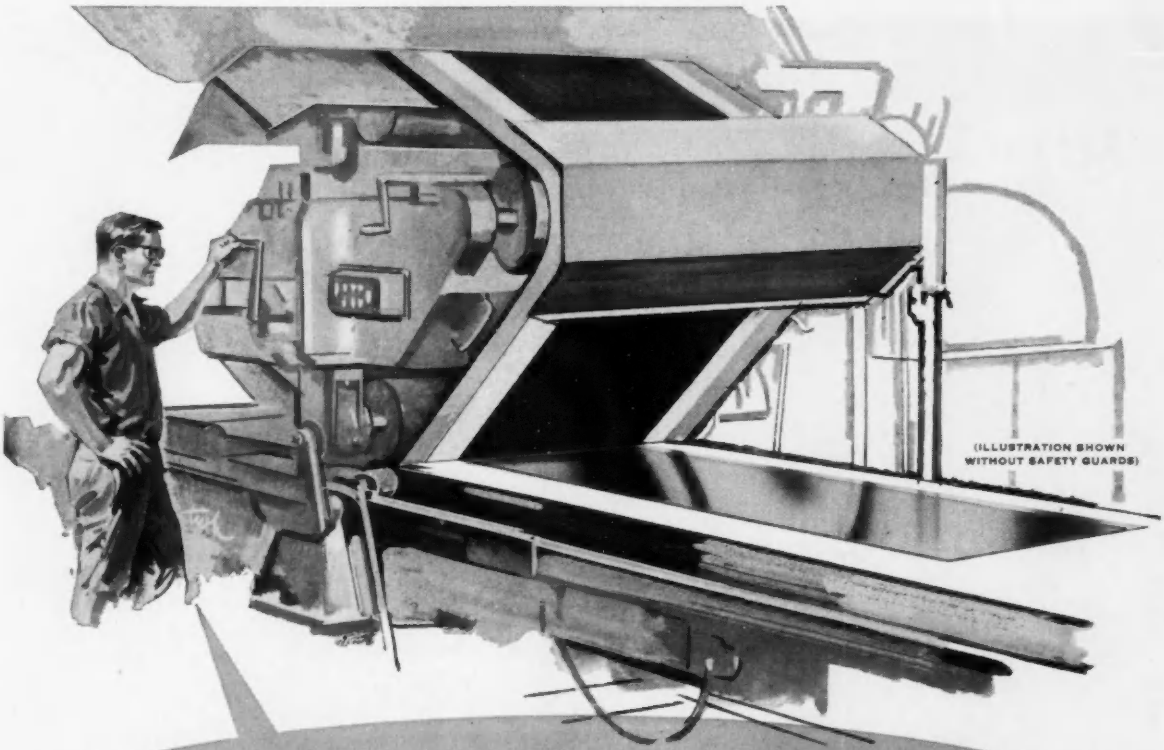
Delco-Remy

ELECTRICAL SYSTEMS

GM GENERAL MOTORS

DELCO-REMY • DIVISION OF GENERAL MOTORS • ANDERSON, INDIANA


AT BCA everything's new but the name



ASK YOUR POLISHER ABOUT THE DIFFERENCE IN STAINLESS SHEET

ALLEGHENY LUDLUM SHEET sets the standard for surface quality. Polishers will tell you—they handle all kinds and they should know. They want stainless sheet without flaws, a smooth surface ready to take further polishing to meet specs.

For stainless sheet delivered to the polisher with an irregular surface, or containing flaws, needs extra work that takes time and adds to cost—even causes loss of thickness.

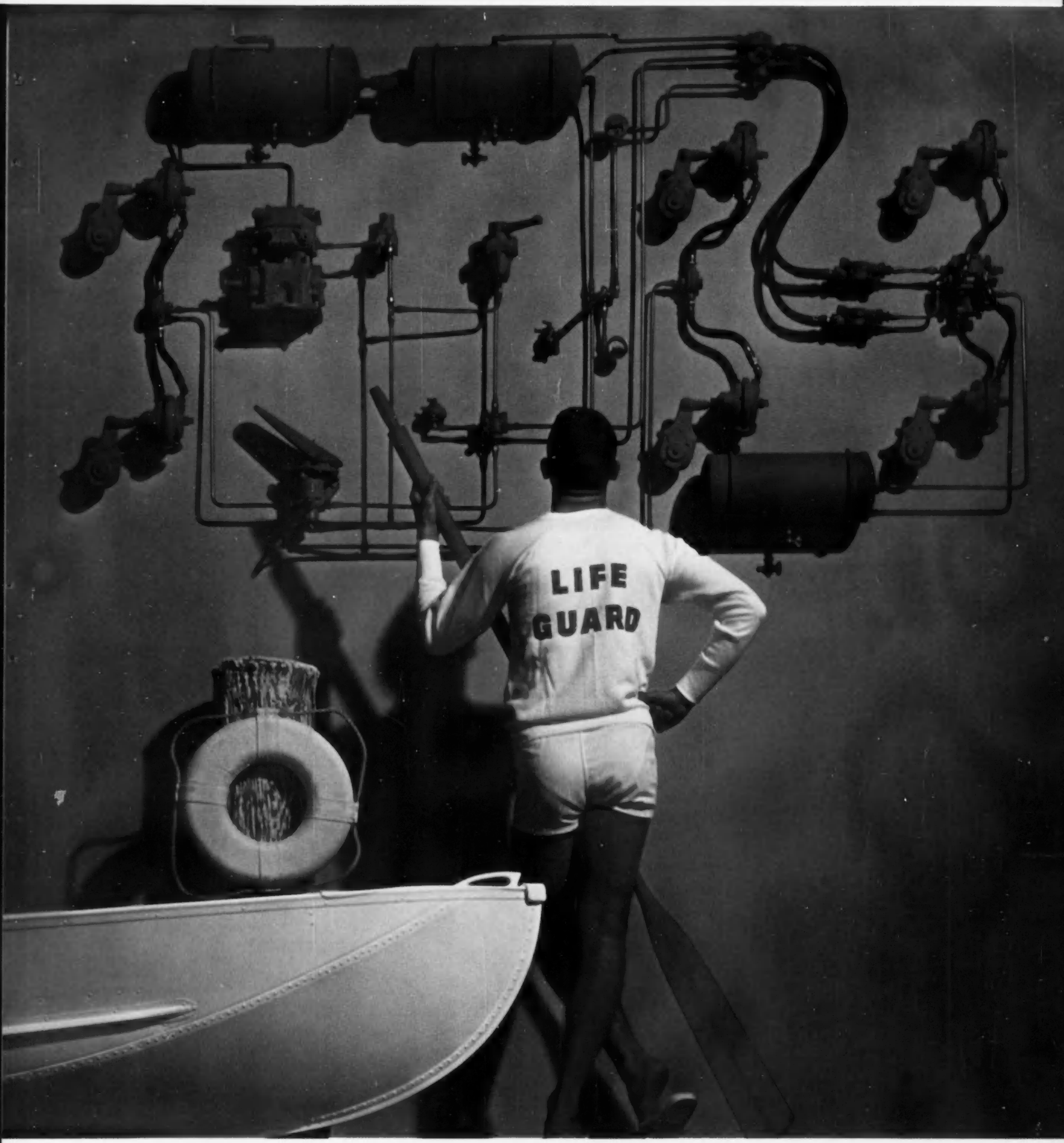
That's why the polishers prefer to work with A-L stainless sheet. For A-L stainless sheet is always smooth . . . a surface without flaws . . . quality stainless, order after order. Your polishing department will also give an enthusiastic reception to stainless sheet from Allegheny Ludlum. Polishers think more of A-L stainless sheet—they will think more of you for ordering it for them. Remember, the pay-off is in the polishing.

For consistent temper, tolerances, and finish in flat rolled stainless products, call your Allegheny Ludlum salesman, or write: *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. SA-9.*

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

2118


LIFE
GUARD

2,200,000 Bendix-Westinghouse Compressors

PROVED DEPENDABLE OVER HUNDREDS OF BILLIONS OF MILES

On April 6, 1960, the 2,200,000th Bendix-Westinghouse compressor passed its final factory tests. As the "heart" of a complete Bendix-Westinghouse air brake system, it was ready to join its 2,199,999 predecessors in providing consistently efficient, dependable stopping power.

Bendix-Westinghouse compressors have been proved in use over *hundreds of billions of miles* on all kinds of commercial vehicles, in every type of service, under all conditions of weather.

Today, the design and engineering experience gained in this vast, practical proving ground benefits *every* user of Bendix-Westinghouse compressors. Three basic models meet the needs of all sizes of commercial vehicles: Tu-Flo 300—for lightweight trucks and school buses; Tu-Flo 400—most widely used by over-the-highway haulers; Tu-Flo 500—for large city and interstate buses, off-the-road vehicles and heavy-duty trucks.

Continue to specify Bendix-Westinghouse Tu-Flo compressors. You can always be confident of their performance-proved safety, economy and dependability!

BENDIX-WESTINGHOUSE AIR BRAKES®

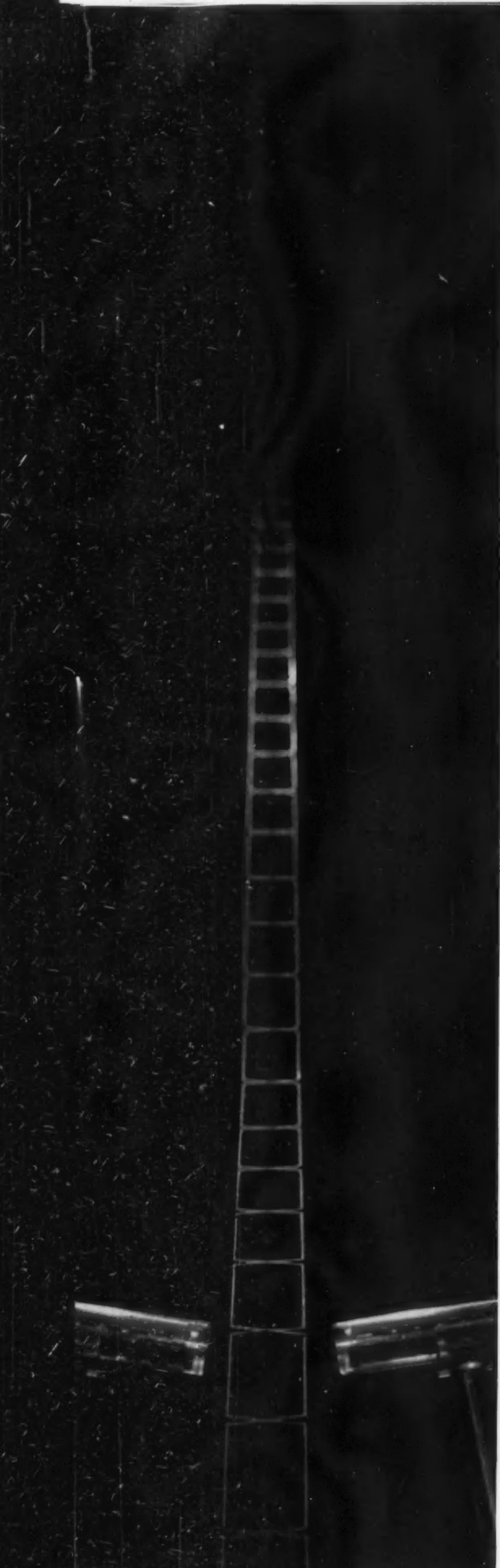
Bendix-Westinghouse

BENDIX-WESTINGHOUSE SINCE 1923 PACEMAKER IN TRANSPORT SAFETY

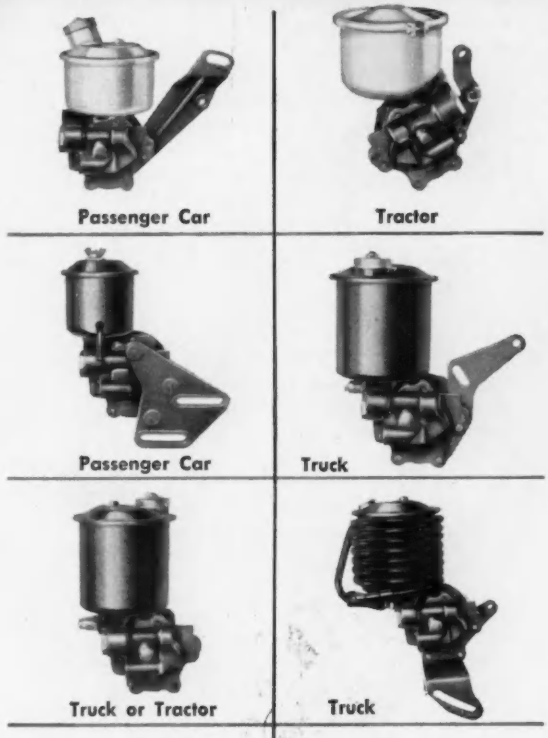
AUTOMOTIVE AIR BRAKE COMPANY

General offices and Factory—Elyria, Ohio. Branches—Berkeley, Cal., and Oklahoma City, Okla.

Test the AUTOLITE CO-AX on your own equipment in farm, marine, earth movers, trucks, cars, diesel and industrial engines...to check its many design advantages, its plus values.



Car pickup coils and road wiring used for guidance and speed control in one experimental automatic highway system under study.



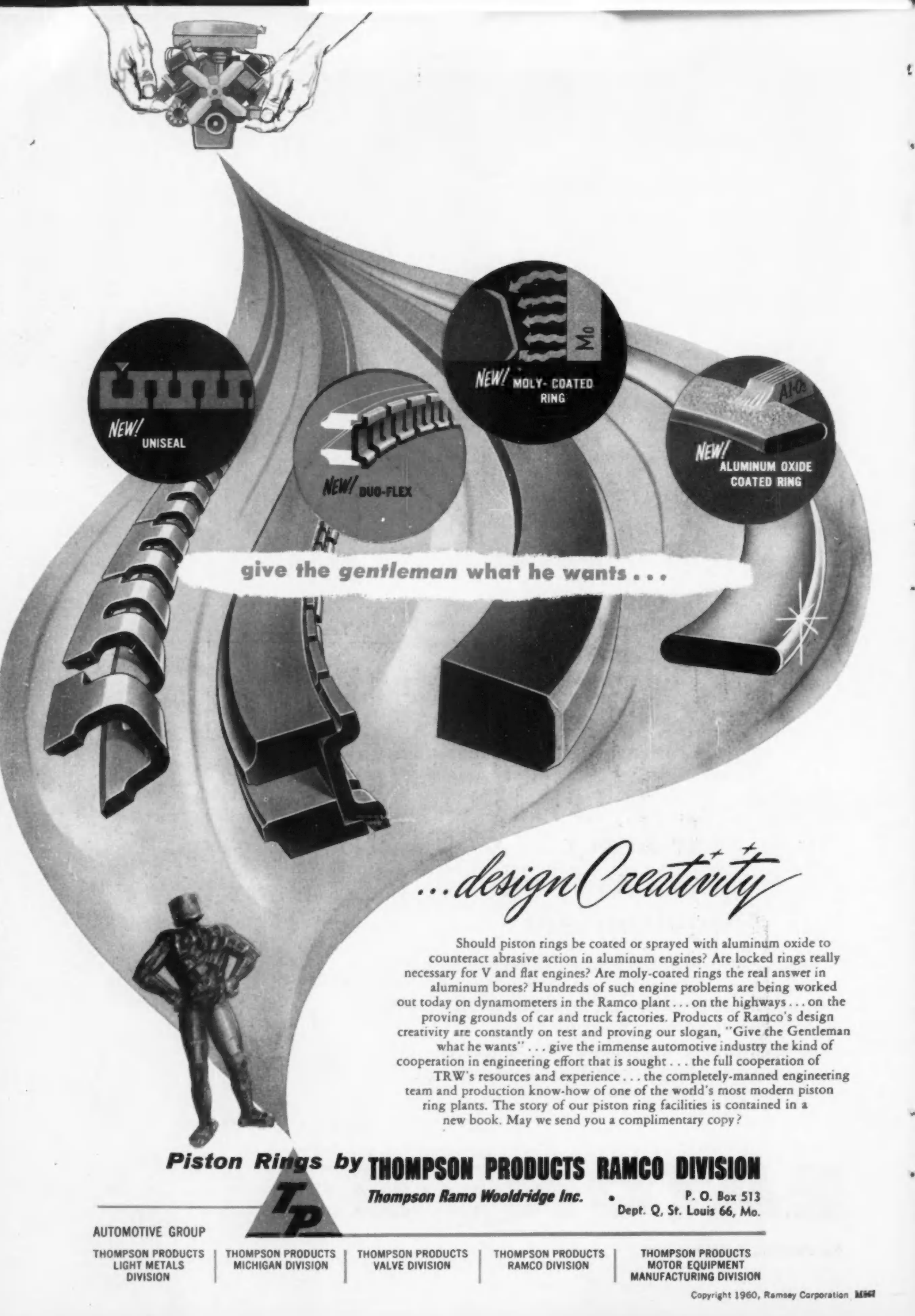
There's an EATON ROLL PUMP for every Power Steering Requirement

Eaton Roll Pumps, performing reliably on leading motor cars, trucks, and tractors, have a number of proven advantages including compact, space-saving design, high efficiency, quiet operation, and simple construction.

Eaton Pump Division sales engineers will be glad to work with you in selecting or developing better pumps to meet your specific requirements. Call on us.

EATON

PUMP DIVISION
MANUFACTURING COMPANY
9771 FRENCH ROAD • DETROIT 13, MICHIGAN


NEW! UNISEAL
NEW! DUO-FLEX
Mo
NEW! MOLY-COATED RING
Al_2O_3
NEW! ALUMINUM OXIDE COATED RING
give the gentleman what he wants . . .
. . . design Creativity
Should piston rings be coated or sprayed with aluminum oxide to counteract abrasive action in aluminum engines? Are locked rings really necessary for V and flat engines? Are moly-coated rings the real answer in aluminum bores? Hundreds of such engine problems are being worked out today on dynamometers in the Ramco plant . . . on the highways . . . on the proving grounds of car and truck factories. Products of Ramco's design creativity are constantly on test and proving our slogan, "Give the Gentleman what he wants" . . . give the immense automotive industry the kind of cooperation in engineering effort that is sought . . . the full cooperation of TRW's resources and experience . . . the completely-manned engineering team and production know-how of one of the world's most modern piston ring plants. The story of our piston ring facilities is contained in a new book. May we send you a complimentary copy?
Piston Rings by THOMPSON PRODUCTS RAMCO DIVISION
Thompson Ramo Wooldridge Inc.
P. O. Box 513
Dept. Q, St. Louis 66, Mo.
TP
AUTOMOTIVE GROUP
THOMPSON PRODUCTS LIGHT METALS DIVISION
THOMPSON PRODUCTS MICHIGAN DIVISION
THOMPSON PRODUCTS VALVE DIVISION
THOMPSON PRODUCTS RAMCO DIVISION
THOMPSON PRODUCTS MOTOR EQUIPMENT MANUFACTURING DIVISION
Copyright 1960, Ramsey Corporation

HIGHER PERFORMANCE WITH SMALLER TURBOCHARGERS

AiResearch's new line of high performance turbochargers gives higher air pressures and more flow per size and weight than ever before achieved in the turbocharging industry, while retaining the high standards of durability which AiResearch established in this field.

Designed for the 50-700 hp engine range, the turbochargers incorporate (a) low inertia, low stress, high pressure ratio impellers and turbine wheels, (b) free vortex turbine housings which eliminate nozzle rings and provide higher turbine efficiency.

Other advantages:

Lower Cost—Radically simplified design and high production tooling have significantly lowered unit cost and service requirements.

Faster Response—Lowered inertia of the rotating group has made response almost immediate.

Greater Versatility—Interchangeable compressor components for each basic turbocharger housing permit a perfect matching of turbocharger to the job; and better engine matching further reduces operating cost.

These new, high performance turbochargers are readily adapted to AiResearch turbocharger control systems which insure optimum engine characteristics over the entire range.

World leader in the development and manufacture of lightweight turbomachinery of all types, AiResearch now has more than 35,000 turbochargers in the field delivering nearly 9 million turbocharged horsepower.

Your inquiries are invited.

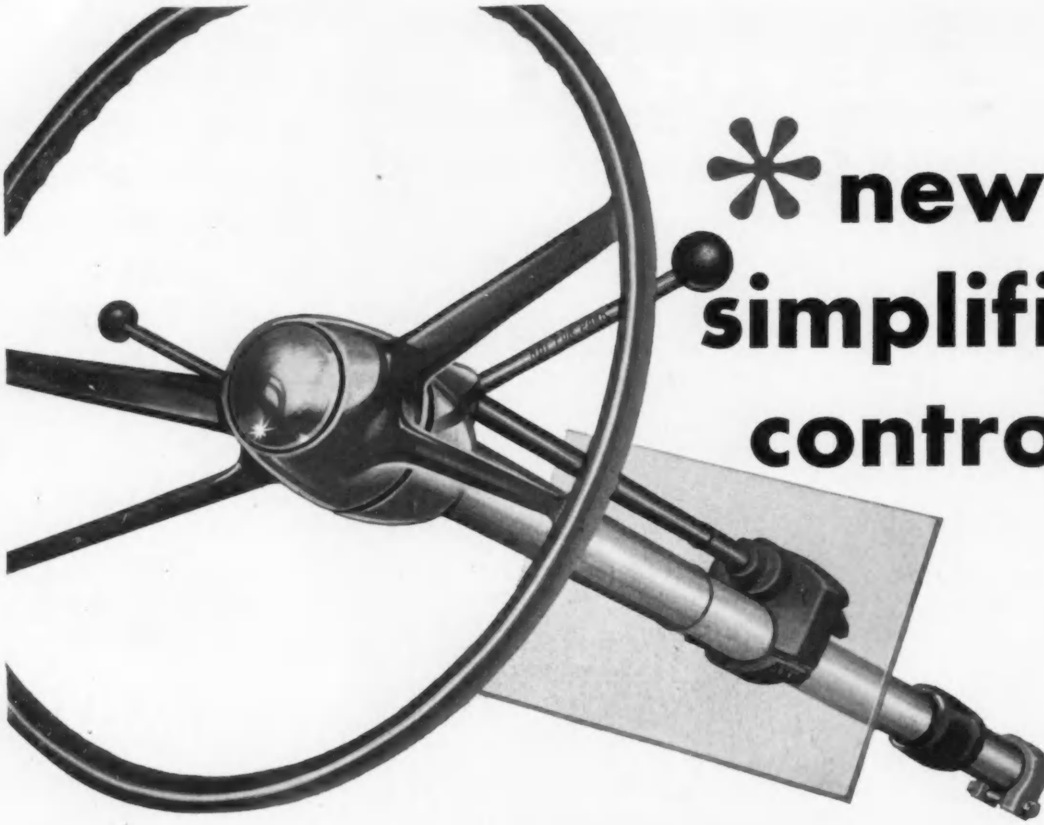
THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS


179
179



* new simplified controls

FOR AIR BRAKES AND DIRECTIONAL SIGNALS

* **Simplicity** is the keynote of these new unified air brake and directional signal controls for trucks. Developed by Ross Gear with the new ICC lighting regs in mind!

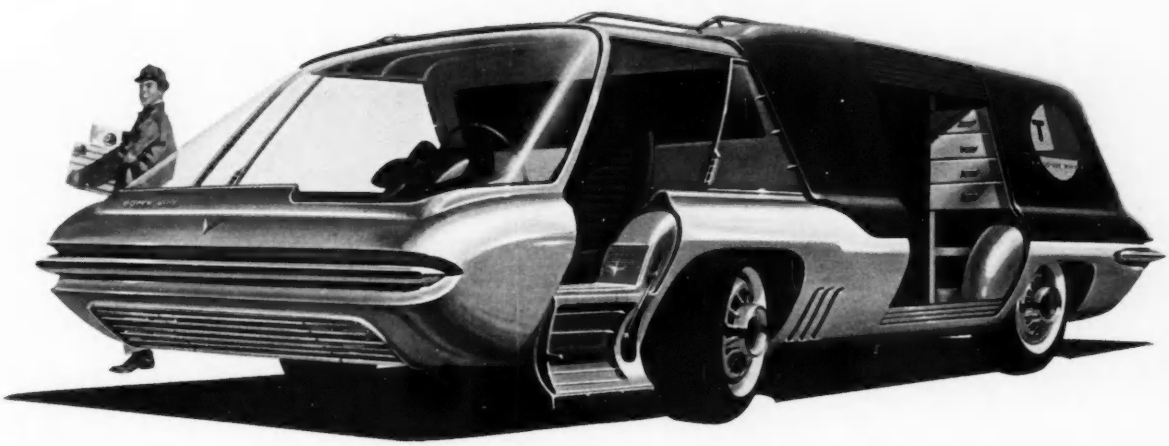
Driver benefits: Precise finger-tip lever control of brakes and signals. Eliminates cab clutter and fussy plumbing. Gives driver more leg room. Helps reduce fatigue. Increases efficiency and safety.

OEM benefits: Complete unit with color keyed wiring. Cuts installation time and costs. Accurate, dependable operation. Conserves cab space. Enhances interior decor.

Ross invites OEM inquiries.

Ross STEERING

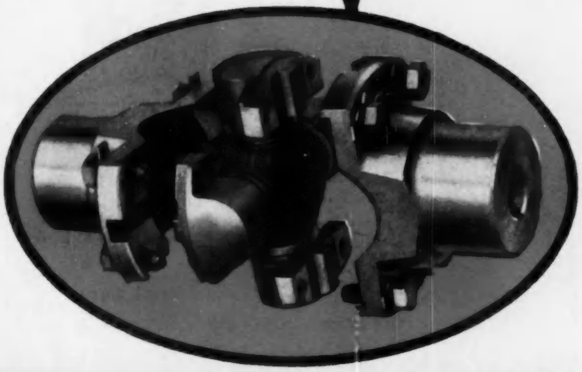
ROSS GEAR AND TOOL COMPANY, INC. • LAFAYETTE, INDIANA
GEMMER DIVISION • DETROIT, MICHIGAN



SOUTHWEST

REDUCE DOWN TIME for SERVICING from HOURS to FIFTEEN MINUTES

MECHANICS Roller Bearing UNIVERSAL JOINTS can be removed and replaced—on the road—in 15 minutes—with a wrench and hammer. Because keys and keyways are machined to fit, there is no danger of destroying the original accurate alignment and balance. This flange-type bearing assembly can be lifted out, simply by removing the cap screw bolts. Let our engineers show you how this and other exclusive MECHANICS Roller Bearing UNIVERSAL JOINT features will help give your product more competitive advantages.



MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2022 Harrison Avenue, Rockford, Illinois
Export Sales: Borg-Warner International 35 So. Wabash, Chicago 3, Illinois

MECHANICS UNIVERSAL JOINTS
Roller Bearing BW
• For Cars • Trucks • Tractors • Farm Implements • Road Machinery •
• Aircraft • Tanks • Busses and Industrial Equipment •

soap or other mild cleansing agent needed only for the most stubborn dirt spots.

Dow supplies PVC resins, with their excellent processing characteristics, to calenderers of fine interior fabrics that help sell cars—make them more enjoyable to own and drive.

Dow Latex 2582, for the underside of automotive fabrics, makes possible even the lightest of colors. This, in turn, opens the door for high-styled fabric patterns with varied weaves, fleck designs and other creative ideas of automotive designers.

In addition, backing formulations made with Latex 2582 are highly resistant to stains – even copper and other metallic dyes—as well as to fading and aging. Dow supplies Latex 2582 both to backing formulators and to fabric manufacturers.

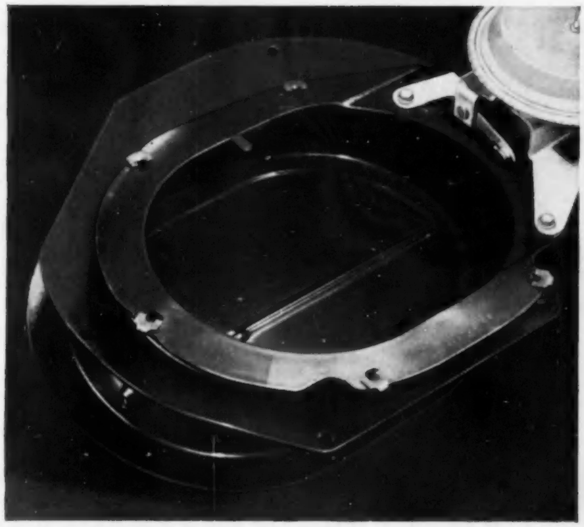
While Dow PVC and Latex 2582 help provide more colorful, more serviceable fabrics, other Dow plastics products help car makers in other ways . . . such as in the examples below.

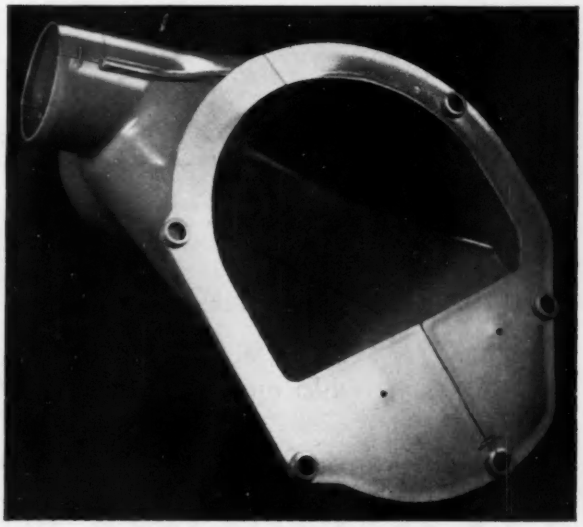
SOLVE TOUGH AIR CONDITIONING PROBLEMS WITH STYRON 440

Air conditioning answer. Styron® 440 helps automotive engineers design better heating and air conditioning system parts. This rugged Dow thermoplastic cannot absorb or transmit water. Thus, no change of dimensions due to moisture, no deterioration. No distortion from the wide range of temperatures encountered in automobile operation, either. Parts made of Styron 440 keep their snug fit throughout their long service life.

These parts are lightweight – much lighter than materials commonly used in such automotive applications. And they require no painting for protection or appearance's sake. The color – any color—is molded into the material. This means no unsightly paint chipping wherever parts are on view in the car interior.

Takes tough treatment. Styron 440 goes to the head of the class on the automotive production line, too. Its excellent moldability and fabrication characteristics cut manufacturing costs neatly. (Very few rejects, for example . . . almost none.) It's tough enough to withstand the knocks and bruises of assembly operations. Takes staples, self-tapping screws and other joining devices without a whimper, and keeps them in place on the roughest roads.





ETHOCEL:
A "HELMET" FOR HEADLIGHT AIMERS!

The same material that has proved its toughness and stamina in helmets for pro football players also helps assure long life for equipment like this headlight aimer. For rugged service, its cover is made of Ethocel®, which provides great toughness and high impact strength over wide temperature ranges.

Besides withstanding severe shock, Ethocel resists chemicals, yet provides dimensional stability to ensure perfect production line assembly of close tolerance parts. Ethocel has the additional advantage of an attractive, glossy surface that's easy to maintain.

For more information, for help in putting these materials and many other members of the Dow family of plastics to work profitably for you, call on Dow. We suggest you contact the nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Department 1710EN9.

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW

See "The Dow Hour of Great Mysteries" on TV

No matter how special your needs...

IT PAYS TO PUT YOUR BRAKING

If you are faced with brake design or supply problems, the following answers to important questions will bring out some facts you should know about Bendix®— and how we can help you.

Q. Why go to Bendix for help with braking problems?

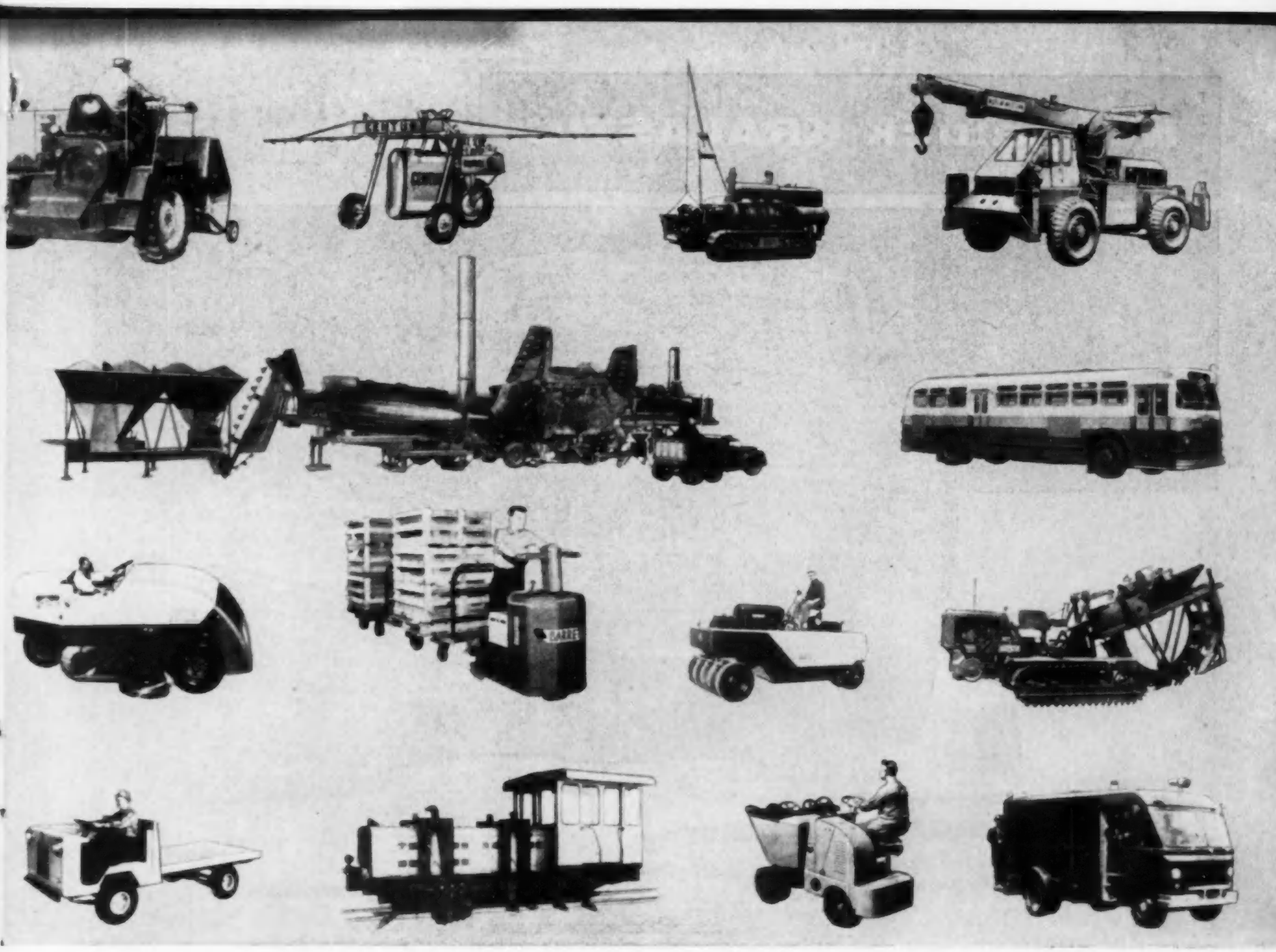
A. Bendix is the world's largest brake manufacturer, with a total lifetime production of over 141 million units. During our 40 years' experience, more people have turned to us for braking help than to any other company. That's why you can feel confident in going to Bendix for help with your braking problems.

Q. What kinds of vehicles use Bendix brakes?

A. Bendix brakes are on vehicles of all kinds: passenger cars, trucks, buses, motorcycles, golf cars, tractors and farm machinery, mine cars, rail cars, ordnance vehicles, trailers, sweepers, rollers, motorized plant dollies, fork lifts, construction equipment. In addition, Bendix brakes are used on many kinds of machine tools and other industrial equipment. This all-around experience can help solve your braking problems.

Q. What specific advantage does Bendix offer in solving automotive braking problems?

A. Bendix is unmatched in automotive brake engineering experience. Our current production schedules include more than 400 different types of automotive brakes alone. Many of these systems are highly specialized. Answers to your braking needs may be found among the types we are already producing. But, no matter how "different" your problem may be, Bendix has the experience and facilities to help you solve it.



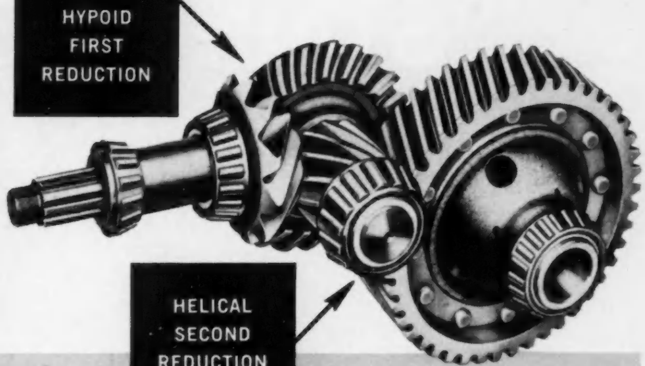
Heavy-Duty Hauling Jobs Are Easy With Timken-Detroit®

Bendix DIVISION South Bend, IND.

Heavy-Duty Hauling Jobs Are Easy With Timken-Detroit®

BALANCED HYPOID-HELICAL DOUBLE-REDUCTION AXLES

Timken-Detroit balanced hypoid-helical double-reduction gearing is unequalled for top performance and dependability. Outstanding advantages that make it the choice of heavy-duty equipment manufacturers and operators are: big, husky gears . . . greater flexibility in gear ratios . . . balanced gear set loadings . . . long life and low maintenance costs. The hypoid first reduction is 30% stronger than spiral bevel, and works in series with the second reduction to take an equal share of the load. In the helical second reduction, strong helical gears with a wide range of ratios insure balanced double-reduction gearing.



240 SERIES

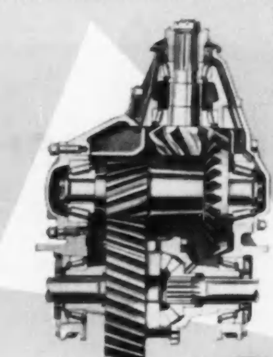
SINGLE-SPEED, HYPOID-HELICAL DOUBLE-REDUCTION

Two full-sized gear sets form a balanced power train—with each gear set accomplishing a substantial reduction. This combination of husky hypoid first reduction gears coupled with rugged, wide-faced helical second reduction gears provides a double-reduction gear set that outperforms all others. Because the ratios of each reduction may be varied, you get a balanced power train with the larger selection of axle ratios for maximum operational versatility and performance.

340 SERIES

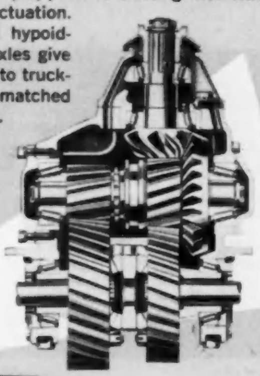
TWO-SPEED, HYPOID-HELICAL DOUBLE-REDUCTION

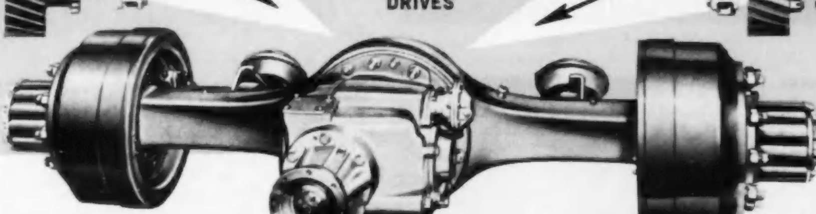
A true two-speed axle which provides two separate gear ratios through the use of two full-size helical gear sets . . . a "fast" ratio for maximum speeds and a "slow" ratio for greatest pulling power. Pick the most efficient gear ratio to meet your requirements of speed, load and road. Spring-flex power shifting provides simple, positive shifting with either air, vacuum or electric actuation. Timken-Detroit two-speed hypoid-helical double-reduction axles give a versatility and economy to trucking operations that is unmatched by other axle gear designs.



choice of two—

INTERCHANGEABLE BALANCED DOUBLE-REDUCTION DRIVES



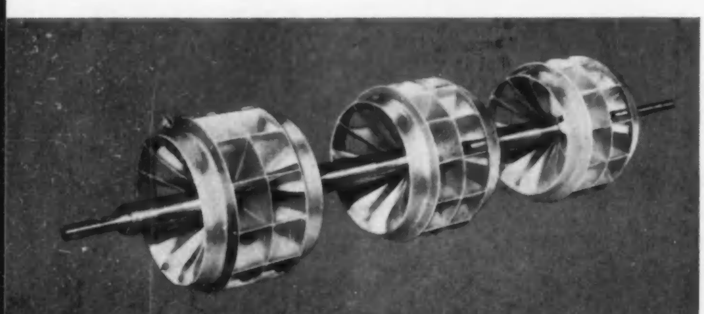


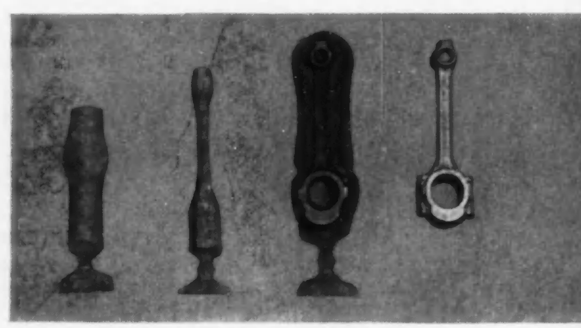
Another Product of... **ROCKWELL-STANDARD CORPORATION**

ROCKWELL R STANDARD

Transmission and Axle Division, Detroit 32, Michigan

THE "BEAUTY" OF REPUBLIC STAINLESS





TO ELIMINATE MACHINING: Buffalo Forge Company uses Republic ELECTRUNITE® Mechanical Tubing for rotor shafts up to 94" long. Close-tolerance concentricity of ELECTRUNITE is vital. Turning at 1,110 rpm, these shafts require exact balance to maintain high operating efficiency. Republic ELECTRUNITE Mechanical Tubing is available in carbon and stainless steel. Mail coupon for details.

TO CUT REJECTS: Herbrand Division of the Bingham-Herbrand Corporation uses Republic AISI-8637 Hot Rolled Alloy Steel in forged connecting rods. Non-varying uniformity has resulted in substantial production economies. 2⅛" bars undergo 11 forging operations. This is followed by heat treatment which produces the mechanical properties designed into the forgings. Send for details on Republic Alloy Steel.

TO SOLVE VIBRATION PROBLEMS: Special nylon inserts in Republic NYLOK® Bolts and Nuts assure a permanent lateral thrust between opposite mating threads. The ideal, single-unit answer to vibration, NYLOK Fasteners have no cotter pins, set screws, lock washers, wiring, or heads. Return coupon for complete information.

+ INDEX TO ADVERTISERS +

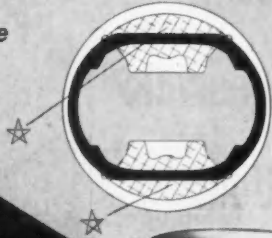
Controlled Expansion
Cooler Running
Greater
Durability

Z CLEAR-O-MATIC

SUPERIOR ENGINEERING DESIGN

The "All-Temperature" Piston
Automatically Maintains Uniform Effective Skirt Clearance at all Temperatures

with these Design Features

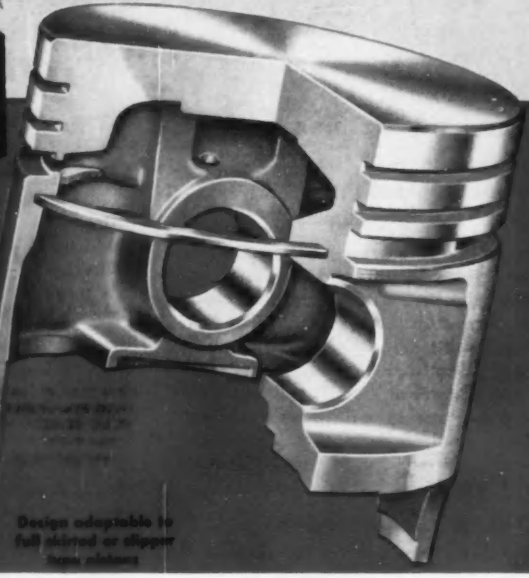


STEEL TENSION MEMBER
Anchored only at pin bosses and cast in positive contact with I. D. of piston skirt.

★ **COOLER RUNNING**
20% greater section for heat conductivity.

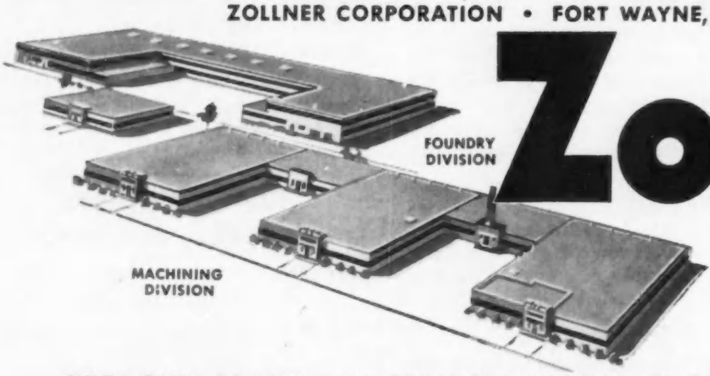
★ **EXTRA DURABILITY**
Greater section above pin bosses provides uncompromised strength for long life.

For any gasoline engine, performance superiority of the Zollner "Clear-O-Matic" Piston is outstanding. The expertly engineered design of this great piston development incorporates desired advantages in addition to the basic expansion control feature. Clear-O-Matic is a remarkably cool running piston with 20% greater area of conductivity for heat dissipation. This greater section also provides uncompromised strength for long-life durability. Only Clear-O-Matic has all these vital advantages. We suggest an immediate test for your engine.



Design adaptable to full skirted or slipper type pistons

ZOLLNER CORPORATION • FORT WAYNE, IND.



ZOLLNER
HEAVY DUTY PISTONS

PRECISION PRODUCTION FROM ENGINEERING TO FOUNDRY TO FINISHED PISTONS

Remember when . . .

HAGEN TURNED SOUTHPAW TO BECOME A FOUR-TIME WINNER

It was the ninth hole of the final round of the 1929 British Open at Muirfield. His second shot lay close to a stone wall—too close for a right handed player. Walter Hagen called for his putter and played it left handed. Then he went on to win the Open for the fourth time—the first American to do it.

How do golf pros meet the tough situations? They draw on the same qualities you look for in the pros of any field—skill and experience.

From its earliest days the automotive industry has realized big economies and top bearing performance by relying on the technical and production skills of the Timken Company. All our experience, over 60 years, has been concentrated on just one type of bearing—the tapered roller bearing—in thousands of applications. This has resulted in a better bearing value that means big benefits for you:

Lower bearing costs from our revolutionary Bucyrus plant producing "Green Light" bearings. Lower warranty costs resulting from superior Timken bearing quality and performance. Lower assembly costs as a result of uniform high precision.

Demand the best professional service; realize the best in performance. Buy Timken bearings instead of a part number. The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®

tapered roller bearings

from the pros of the bearing business